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MARCH 1936

CONTENTS

	Page
Determination of Altitudes from the Adiabatic Chart and the Refsdal Aerogram. (3 figs.) Paul J. Kiefer	69
Variability Isocrymal Maps for the Great Plains. (9 figs.) Earl E. Lackey	71
Intercorrelations Between Climatic Variables in the Corn Belt. (7 figs.) John Kerr Rose	76
An Observation of Unusual Ice Crystals. (3 figs.) C. Robert Elford	83
Monthly Temperatures, 1925–35, at the Montezuma Station of the Smithsonian Institution. C. P. Butler	83
Erratum in the Smithsonian Meteorological Tables: Temperature Correction Factor in the Hypsometric Formula (English Measures). Vincent E. Jakl	84
Composition and Origin of Dust in the Fall of Brown Snow, New Hampshire and Vermont, February 24, 1936. W. O. Robinson	86
Meteorological History of the Brown Snowfall of February 1936. Horace R. Byers	86
Dust Storms February and March 1936, in the United States. (1 fig.) Robert J. Martin	87
Bibliography	88
Solar Observations	90
Aerological Observations	92
Rivers and Floods	94
Weather on the Atlantic and Pacific Oceans	94
Climatological Tables	97
Charts I–XII.	

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DETERMINATION OF ALTITUDES FROM THE ADIABATIC CHART AND THE REFSDAL AEROGRAM

By PAUL J. KIEFER

[U. S. Navy Postgraduate School, Annapolis, Md., March 1936]

The recently-developed Refsdal "aerogram" [1] possesses the interesting property of providing an exceedingly simple, direct and exact means of evaluating geopotential, and hence altitude, from the graph of an aerological sounding. The aerogram includes, in fact, a geopotential scale on the right margin for this purpose.

A somewhat parallel, and almost equally simple and exact, method of altitude determination with the familiar adiabatic chart does not appear to have had the attention that it seems to merit.[2] This method does not involve any inherent approximations; and it avoids the rather awkward constructions, and the moderate approximations, that are involved in the usual method of using the chart for this purpose.

The procedure depends on the familiar static relation for the atmosphere,

$$dp=-\rho g dz=-\frac{p}{RT}g\,dz; \tag{1}$$

or, integrating,

$$z=-\int\frac{R}{g}T\frac{dp}{p}=-\int\frac{R}{g}T\,d(\log_e p) \tag{2}$$
$$=\frac{R}{g}\int T\,d(\log_e p),$$

if R and g may be regarded as practically constant. Here the integral is evidently the area between the line that represents zero temperature and the line that represents simultaneously-observed temperatures and pressures at various altitudes, plotted in the coordinates of the adiabatic chart, viz, temperature and logarithm of pressure. Thus, the area under consideration is *abcd* in figure 1, where the heavier solid lines represent the boundary of the usual adiabatic chart.

As this area will equal the area *amnd* if a temperature line *mn* is so drawn that area *cno* equals area *obm*, it follows that the absolute temperature corresponding to line *mn* may properly be regarded as a "mean effective" (constant) temperature which would be the equivalent of the actual temperatures insofar as the actual temperatures compositely affect the altitude computations.

For a mean effective absolute temperature, T_e, so determined, equation (2) would reduce to,

$$z-z_o=\frac{R}{g}T_e(\log_e p_o-\log_e p) \tag{3}$$
$$=29.3\ (t_e+273)(\log_e p_o-\log_e p) \tag{4}$$
$$=67.3\ (t_e+273)(\log_{10} p_o-\log_{10} p), \tag{5}$$

where t_e=the mean effective centigrade temperature ascertained by so drawing a temperature line (intersecting

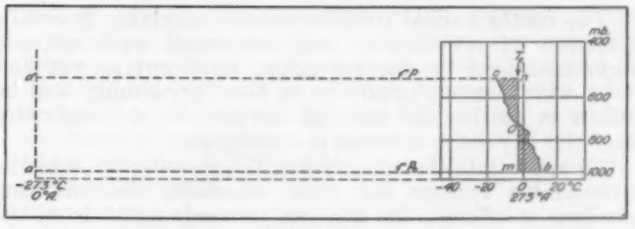

FIGURE 1.

the t–p record on the adiabatic chart) that the areas *cno* and *obm* in figure 1 are equal; and 29.3 or 67.3 is the constant, corresponding to the effective average values of g and the gas constant R for dry air, that gives the altitude in *meters*.

The first step in the computation of the altitude difference between two levels at which the observed pressures are p and p_o is thus to locate t_e; the second and only further step is to ascertain the logarithms of p_o and p, and perform the multiplication in equation (4) or (5).

The t_e line may be located with sufficient accuracy by mere inspection, in conjunction with a transparent straight edge; a more exact equalization of the two areas is ordinarily quite unnecessary: Inspection will easily locate the line to within 0.5° C. on the usual adiabatic chart; the error in T_e would, therefore, not exceed, say 0.18 percent. This gives the absolute temperature to the fourth significant figure, well within the range of certainty that attaches both to instrumental observations of temperature and pressure and to the value of R. A more exact equalization may, of course, be made by the use of a planimeter.

[1] A. Refsdal. Das Aerogramm. Met. Zeit., 52:1–5. 1935.
[2] On the method of using the tephigram for this purpose, see Sir Napier Shaw, Geopotential and Height in a Sounding with a Registering Balloon. Mem. Roy. Met. Soc., Vol. I, No. 8. 1927.

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For humid air, either an appropriate average value of R for the mixture may be employed, or else the *virtual* temperatures may be plotted.

The advantages of the preceding method are: (*a*) Absence of any inherent approximations; (*b*) ease with which accuracy may be obtained; and (*c*) general rapidity and simplicity of the operations.

These features are in contrast to the inherent approximations and troublesome nature of other methods. Those who are familiar with the latter are aware of the necessity for (*a*) determining the arithmetical mean temperature for each series of segments into which the sounding record is divided, (*b*) finding the slope of the dry-adiabatic line through each of these points, (*c*) delineating and progressively joining successive lines with these slopes,

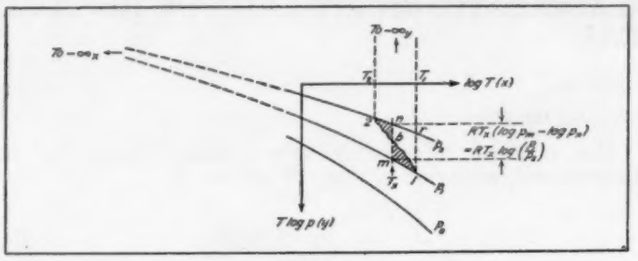


FIGURE 2.

(*d*) reading off the subtended distances on the temperature axis, (*e*) correcting these distances, etc.[3] The method outlined above would seem to offer very real and distinct advantages.

THE COORDINATE SYSTEM OF THE REFSDAL DIAGRAM

The mathematical considerations underlying Refsdal's selection of coordinates, and connected with altitude determinations by the aerogram, have not as yet had very wide dissemination; hence this opportunity will be taken to outline the basis of the system of coordinates and the dry-stage lines of the aerogram.

To appreciate the character of the coordinates, and the presumable reasons for their selection, the following analysis is offered; the analysis proceeds again from the familiar static relation, equation (1):

From equation (2),

$$-g\,dz=R\,Td\,(\log p) \qquad (2)$$

$$=R[d(T\log p)-(\log p)dT] \qquad (6)$$

$$=R\left[d(T\log p)-(T\log p)\frac{dT}{T}\right]$$

$$=R[d(T\log p)-(T\log p)d(\log T)]. \qquad (7)$$

Refsdal has in effect selected as ordinate (T log p), and as abscissa (log T). These are the coordinates indicated in figure 2. The absolute zero of temperature would be located at an infinite distance to the left, since log $0=-\infty$; similarly (for any finite temperature) the zero of pressure would be at an infinite distance *upward*, since the ordinate increases downward and T log $0=-\infty$.

This coordinate system has the following unique properties:

1. At *constant temperature*, from equation (2) and with subscripts that correspond to the representative points in figure 2, we have

$$g(z_n-z_m)=RT_x\log(p_1/p_2)=R\,[(T_x\log p_m)-(T_x\log p_n)]. \qquad (8)$$

Since the bracketed term on the right of this equation is the linear separation of the intersections of a constant-temperature line with the several pressure lines, therefore this linear distance is a direct index to the difference of geopotential, and thus of altitude, along an isothermal line.

Furthermore, considering the equivalence of the bracketed term and the term T_x log (p_1/p_2), it appears that the separation of two pressure lines, measured along a temperature line or ordinate, is directly proportional to the absolute temperature that corresponds to this ordinate. This fact accounts for the progressive divergence of the pressure lines in the figure with increasing temperature; it also shows that along any particular temperature ordinate, the distances from some one line of constant pressure p_o to other lines for pressures p_1 and p_2 are in the ratio

$$\frac{\log(p_o/p_1)}{\log(p_o/p_2)}.$$

The above considerations are, in fact, the only ones that need be or are taken into account in the construction of pressure lines on the actual working diagram as issued and copyrighted by Refsdal. On that diagram the pressure line for 1,050 *mb*, the effective p_o line, is arbitrarily made rectilinear, and the other pressure lines are then merely drawn relatively to the 1,050 line in conformity with the foregoing. This modification in no way invalidates the attribute of the diagram that was developed from equation (8).

The appearance of the actual diagram is thus that of figure 3. Values of the function T log p do not appear on the chart, although we have seen that it is the fundamental ordinate of the coordinate system.[4]

2. *At constant pressure*, from equation (1) with dp or d (log p) equal to zero, we have

$$-g\,dz=dp/\rho=0,$$

so that, from equation (7),

$$d\,(T\log p)_p=(T\log p)\,d\,(\log T)_p, \qquad (9)$$

where the subscript denotes the constancy of pressure.

By integration from T_2 to T_1, we obtain

$$-(T_2-T_1)\log p=-(T_2\log p-T_1\log p)$$

$$=\int_{T_2,\,p}^{T_1,\,p}(T\log p)\,d\,(\log T). \qquad (10)$$

Here the left side of the equation is represented graphically on figure 2 by the linear vertical separation (along the

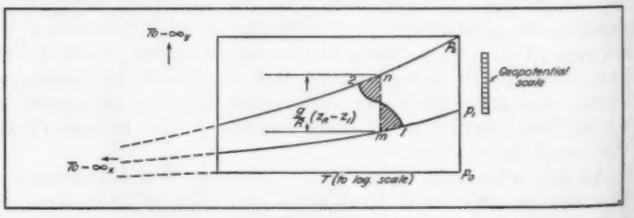


FIGURE 3.

T log p ordinate) of two points such as (*2*) and (*r*) located at the pressure line for p_2. The right side of the equation is represented graphically by the area (between the T_2 and T_1 lines) that would extend from the p_2 line upward to $-\infty$. The indicated equality thus has some significance on figure 2; any significance it may have on figure 3 is not readily apparent nor particularly important.

[3] *See* L. P. Harrison: Mathematical Theory of the Graphical Evaluation of Meteorograph Soundings by Means of the Adiabatic Chart. MO. WEA. REV., vol. 63, pp. 123-135. 1935.

[4] This method of determining pressure lines with respect to a rectilinear contour for some p_0 amounts, in effect, to placing the axis of T log p at an angle of less than 90° with the axis of log T, and employing a nonuniform scale for T log p.

By integration from 0 to, say, T_2 (or from $-\infty$ to $\log T_2$) at constant pressure p_2, we obtain

$$T_2 \log p_2 = \int_{-\infty}^{\log T_2} (T \log p)\, d\,(\log T); \qquad (11)$$

on figure 2 the integral would be represented by the total area (between the T_2 line and $-\infty$ *to the left*) that would extend from the p_2 line *upward* to $-\infty$. Such areas will hereinafter be denoted by symbols of the type $(-\infty_x)$ (p_2) $(-\infty_y)$. Although this area is of infinite extent, it does possess a direct utility that becomes evident in the following paragraph.

3. *For any joint variation of temperature and pressure,* as with altitude, we have from equation (7),

$$g\,(z_2-z_1) = R\left[\int_{(2)}^{(1)} d\,(T \log p) - \int_{(2)}^{(1)} (T \log p)\, d\,(\log T)\right] \qquad (7)$$

$$= R[(T \log p)_1 - (T \log p)_2 - \int_{(2)}^{(1)} (T \log p)\, d\,(\log T)] \qquad (12)$$

On figure 2 the three terms on the right of equation (12) would be represented graphically by the area

$$(-\infty_x)\ (p_1)\ (-\infty_y) - (-\infty_x)\ (p_2)\ (-\infty_y) - (-\infty_y)\ (p_1)\ (p_2)\ (-\infty_y) = (-\infty_x)\ (p_1)\ (p_2)\ (-\infty_x).$$

Thus,

$$g\,(z_2-z_1) = R \cdot \text{area}\,[(-\infty_x)\ (p_1)\ (p_2)\ (-\infty_x). \qquad (12a)$$

Now, if on figure 2 a temperature line *mn* is drawn similar to the one used in the adiabatic chart, figure 1, so that area *2nb* equals area *bim*, we have

$$g\,(z_2-z_1) = R \cdot \text{area}\,[(-\infty_x)\ (n)\ (m)\ (-\infty_x)] = R \cdot \text{area}\,[(-\infty_x)\ (m)\ (-\infty_y) - (-\infty_x)\ (n)\ (-\infty_y)], \qquad (13)$$

or, by the remarks following equation (11),

$$g\,(z_2-z_1) = R[(T \log p)_m - (T \log p)_n] = R\,T_{mn}\,(\log p_1 - \log p_2). \qquad (15)$$

The significance of equation (14) is that, if the temperature-pressure record of a sounding be depicted on the coordinates log T and T log p, and if we delineate a "mean effective" temperature line *mn* in the way specified, then the difference of geopotential, and thus of altitude between points *1* and *2*, is equal to R times the linear separation of points *m* and *n;* this conclusion is valid so long as the construction of the pressure lines conforms to the requirements indicated above, which are fulfilled in the Refsdal chart. As previously mentioned, that chart provides a scale on the right margin to which linear distance *mn* may be transferred and from which the difference of geopotential may be read directly.

The identity of equations (3) and (15) will be evident, as well as the essential identity of the constructions for determining the required mean effective temperature on the two charts. The only essential difference between the two procedures for the determination of geopotential and altitude in a static atmosphere is that with the adiabatic chart, R, T_s and log (p_o/p_1) must actually be multiplied, whereas by a rather circuitous but very ingenious line of reasoning Refsdal has evolved a chart and scale that provide the product directly.

The Refsdal chart also provides the usual dry and wet adiabatics, the mixing ratio at saturation, etc. As on the tephigram, areas on the Refsdal chart have the dimension and significance of energy; but, unlike the tephigram, distances along the ordinates have also the above significance of geopotential energy.[5]

The writer ventures to suggest that meteorology is much in need of a diagram that will represent other energy data for the atmosphere, in addition to geopotential, as linear distances rather than as areas. Areas are too troublesome of accurate evaluation and frequently too difficult of proper interpretation. It is exactly for this reason that the engineer has abandoned the temperature-entropy diagram in practical work, and has found the Mollier (enthalpy-entropy) chart to be so much more useful.

[5] Cf. footnote 2, p. 69.

VARIABILITY ISOCRYMAL MAPS FOR THE GREAT PLAINS

By EARL E. LACKEY

[University of Nebraska, Lincoln, Nebr., March 1936]

The series of variability isocrymal maps of the Great Plains described in this paper is a continuation of a corresponding study recently made by the author for Nebraska only.[1]

In constructing a series of frost maps, it was considered more desirable to use median and percentile dates than dates calculated from means and standard deviations. Not only is it easier to calculate percentile dates from the median, but also such dates register exactly what has occurred according to the record, whereas dates calculated from the means and standard deviations, although they may present a symmetrical picture, do not indicate what actually has occurred.

Means have not been computed for all the 500 stations in the 10 States represented by this study; but means and corresponding percentile deviations have been computed for Nebraska.[2] It was found that both the mean date and median date of the first killing frost of autumn at Beatrice, Nebr., according to a 43-year record, was October 10. The mean dates and median dates for the 71 Nebraska stations were in agreement only 30 percent of the time. In normal distributions medians and means are always in agreement.

The mean date of the first killing frost of autumn at Madison, Nebr., according to a 37-year record, was October 5—3 days *earlier* in the year than the median date, October 8. Expressed in another way, the first killing frost of autumn at Madison occurred earlier than the mean date 15 times, and later 20 times. At 25 percent of the 71 Nebraska stations, the mean date of the first killing frost of autumn was *earlier* than the median date.

The mean date of the first killing frost of autumn at Broken Bow, Nebr., according to a 39-year record, was October 2—7 days *later* in the year than the median date, September 25. In fact, the first killing frost of autumn occurred 23 times before, and 16 times after, the mean date. Of course the first killing frost of autumn occurred

[1] The Geographical Review, Vol. XXVI, No. 1, January 1936.
[2] Climatic Summary of the United States (U. S. Weather Bureau Bulletin W), Sections 38 and 39. Washington 1930.

just 19 times before and 19 times after September 5, the median date. At 46 percent of the 71 Nebraska stations, the mean date of the first killing frost of autumn was *later* than the median date. In other words, if the farmers of Nebraska think of the mean in a normal distribution when making their calculations concerning the first killing frost of autumn, most of them miss by far what actually has happened; for, according to the record, killing frost has occurred at the 71 Nebraska stations nearly twice as often before the mean as after it (ratio 46:24).

At Ashland, Nebr., with a 41-year record, the last killing frost of spring according to both the mean and the median is April 27. The mean and median dates agree at 25 percent of the 71 Nebraska stations.

The mean date of the last killing frost of spring at Lexington, Nebr., according to a 39-year record, is May 13—7 days later than the median, which is May 6. Killing frost at Lexington actually occurred earlier 24 times, and later 15 times, than the mean date. At 50 percent of the 71 Nebraska stations, the mean date of the last killing frost of spring has been later than the median.

The mean date of the last killing frost of spring at Atkinson, Nebr., is May 10—3 days earlier than the median date, which is May 13. Killing frost at Atkinson actually has occurred earlier 16 times, and later 18 times, than the mean date. This has been the case at 25 percent of the 71 Nebraska stations.

The study of frost frequency indicates therefore that the last killing frost of spring has occurred at Nebraska stations later than the mean date twice as often as earlier.

Thus it is seen that the frost hazard in spring for Nebraska as a whole is not as great as the mean might lead one to believe, especially if one is thinking of the mean in a normal distribution.

It stands to reason, therefore, that the farmer will find the median a safer guide than the mean, because it indicates just what the frost hazard has been. To the extent that one considers the past record as a safe criterion, the median and percentile deviations may be used as a guide in the planting of crops and other agricultural operations affected by killing frost.

Although corresponding computations for the other States of the Great Plains have not been made, it is assumed that the Nebraska case is typical in respect to the relation between means and medians. It is desirable that other samples in the area be worked out in order to check this assumption, however.

FINDING MEDIAN AND PERCENTILE DATES

At Independence, Kans, the median date for the first killing frost of autumn, i. e., the date on or before which the first killing frost occurs 50 percent of the time, is October 23. This date is based on what has actually occurred during the past 57 years, and was worked out in the following manner. On a special calendar for September, October, and November the dates of the first killing frosts of autumn were checked for each of the 37 years from 1877 to 1934, respectively. Counting forward from the earliest date, September 26, the 50-percentile or 29th date falls on October 23. From this as a median, one may count forward or backward to find any desired percentile date. For purposes of this study the 20-, 50-, and 80-percentile dates were computed. These dates are shown to be October 10, October 23, and November 1, respectively; they signify that the first killing frost of autumn occurred at Independence on October 10, *or earlier*, 20 percent of the time, on October 23, *or earlier*, 50 percent of the time, and November 1, *or earlier*, 80 percent of the time. A similar sheet [3] was prepared for each of the 500 stations on the Great Plains. Only 40 stations with a record of fewer than 20 years were included in the study; the longest record was that of Manhattan, Kans., 71 years.

On a special calendar for March, April, and May the 20-, 50-, and 80-percentile dates were computed for the last killing frost of spring for Independence. These dates are shown to be April 27, April 13, and April 1, respectively. This signifies that a killing frost occurred at Independence on April 27, *or later*, 20 percent of the time, on April 13, *or later*, 50 percent of the time, and on April 1, *or later*, 80 percent of the time. A similar sheet was prepared for each of the 500 stations on the Great Plains.

ISOCRYMAL MAPS FOR AUTUMN

With these computations for the 500 stations, the 50-percentile or median dates for the first killing frosts of autumn were entered on an outline map of the Great Plains and isocrymes drawn with an interval of 5 days (fig. 2). An isocryme on this map means that the last killing frost of autumn occurred on the designated date, *or earlier*, 50 percent of the time. Each of the other maps for autumn is to be similarly interpreted.

The 20-percent and 80-percent isocrymal maps for autumn are more important, perhaps, than the 50-percent or median map (figs. 1 and 3). On these maps the isocrymes pass through those places where the first killing frost of autumn occurred on the designated dates, *or earlier*, 20 percent of the time, and 80 percent of the time, respectively. For example, in only 20 percent of the years at Topeka, Kans., has the first killing frost of autumn occurred by October 8, *or earlier*, whereas in 80 percent of the years it has occurred on October 27, *or earlier*.

As examples of the practical application of these data, we may mention first that a cattle feeder may desire a large late-maturing variety of corn for ensilage; the variability isocrymal maps for autumn inform him as to the percentage of frost hazard he is risking with such varieties. Again, in selecting seed corn from the standing stalk in autumn, if he accepts as a criterion what has happened in the past, the farmer can make an intelligent guess as to the approximate date on, or before, which such work should be completed.

ISOCRYMAL MAPS FOR SPRING

The method used in constructing the spring maps was similar to that employed in making the autumn maps. For Kearney, Nebr., it was found that the last killing frost of spring occurred on May 13, *or later*, 20 percent of the time; on April 30, *or later*, 50 percent of the time; and on April 25, *or later*, 80 percent of the time.

With corresponding data at hand for the 500 weather stations on the Great Plains, the 20-, 50-, and 80-percentile maps for spring were constructed (figs. 4, 5, and 6).

A farmer in the vicinity of Kearney, Nebr., knowing that early potatoes as a rule bring high prices, or mature before the hot season arrives, may use the spring isocrymal maps to advantage. If he thinks that planting potatoes early and taking a chance with frost is better than risking a low price, he may desire to plant so the potatoes will be up on April 25, with a 90-percent hazard, rather than to plant so they will just be coming up on

[3] Climatic Summary of the United States (U. S. Weather Bureau Bulletin W), Sections 8, 9, 10, 11, 13, 14, 23, 24, 28, 29 ,30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, and 43.

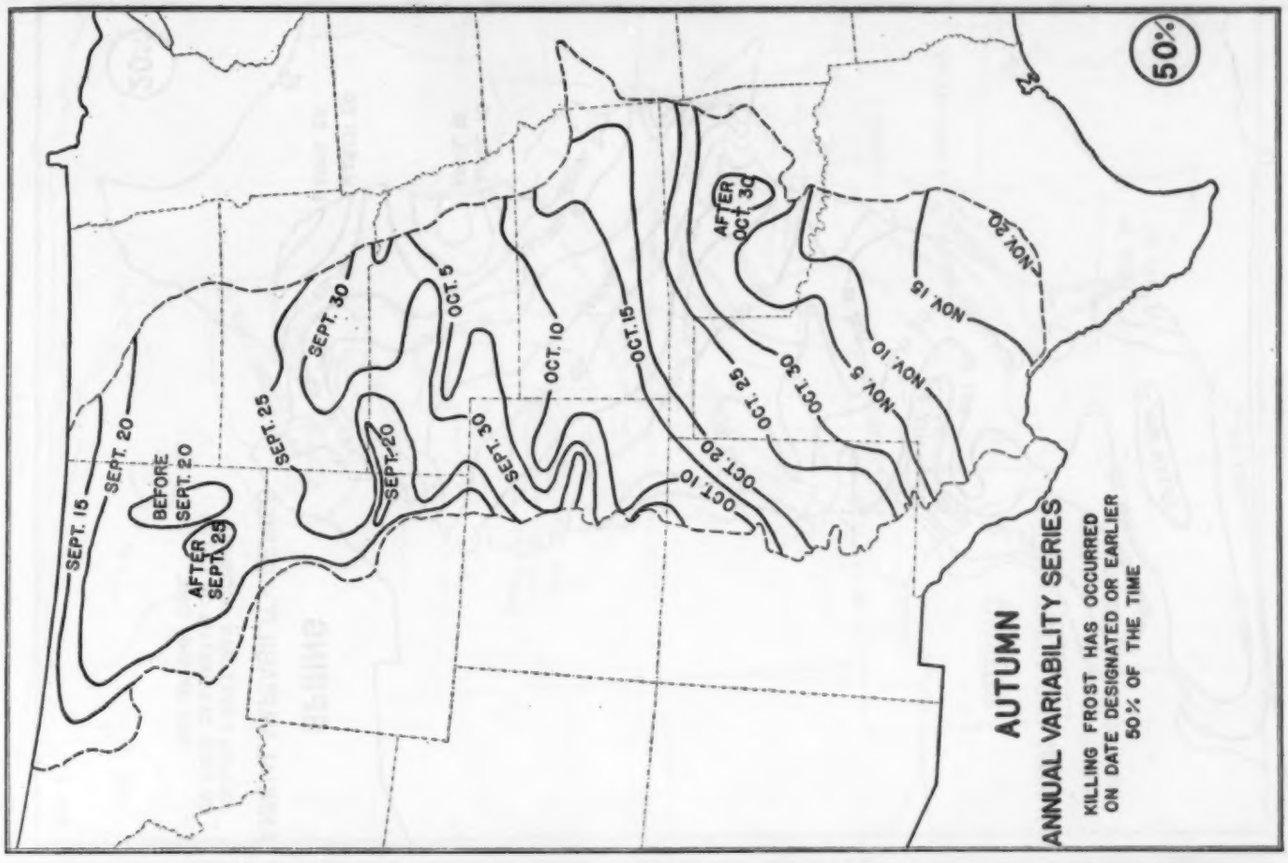


FIGURE 2.

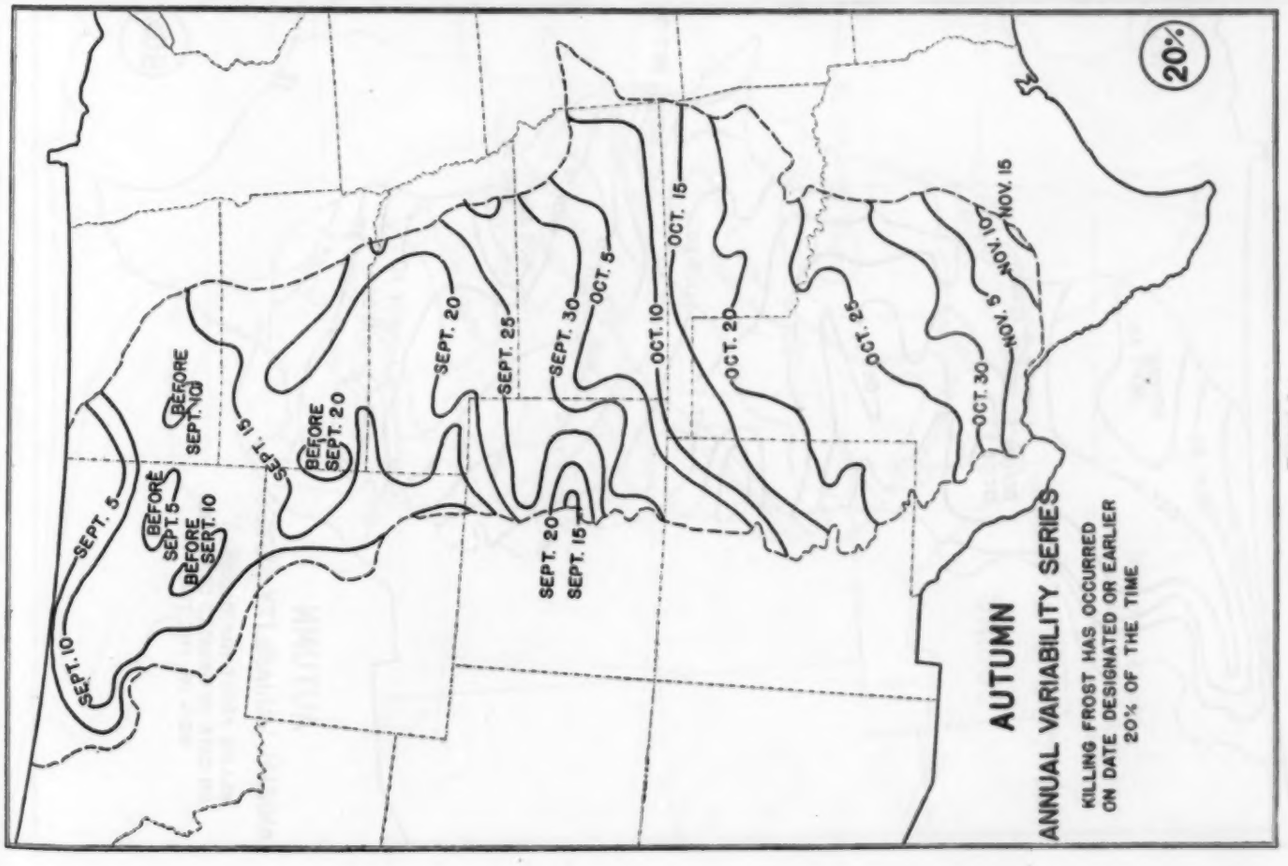
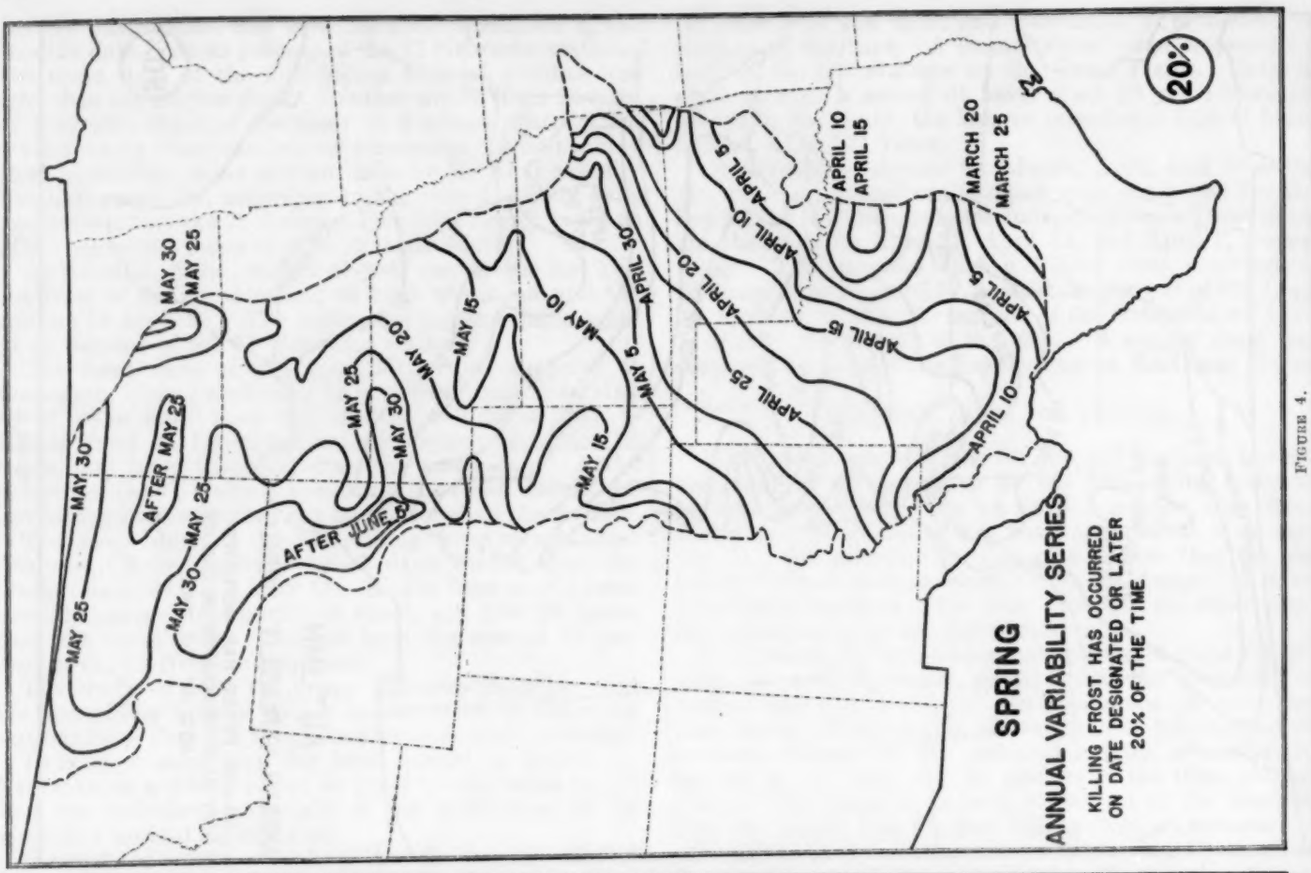


FIGURE 1.



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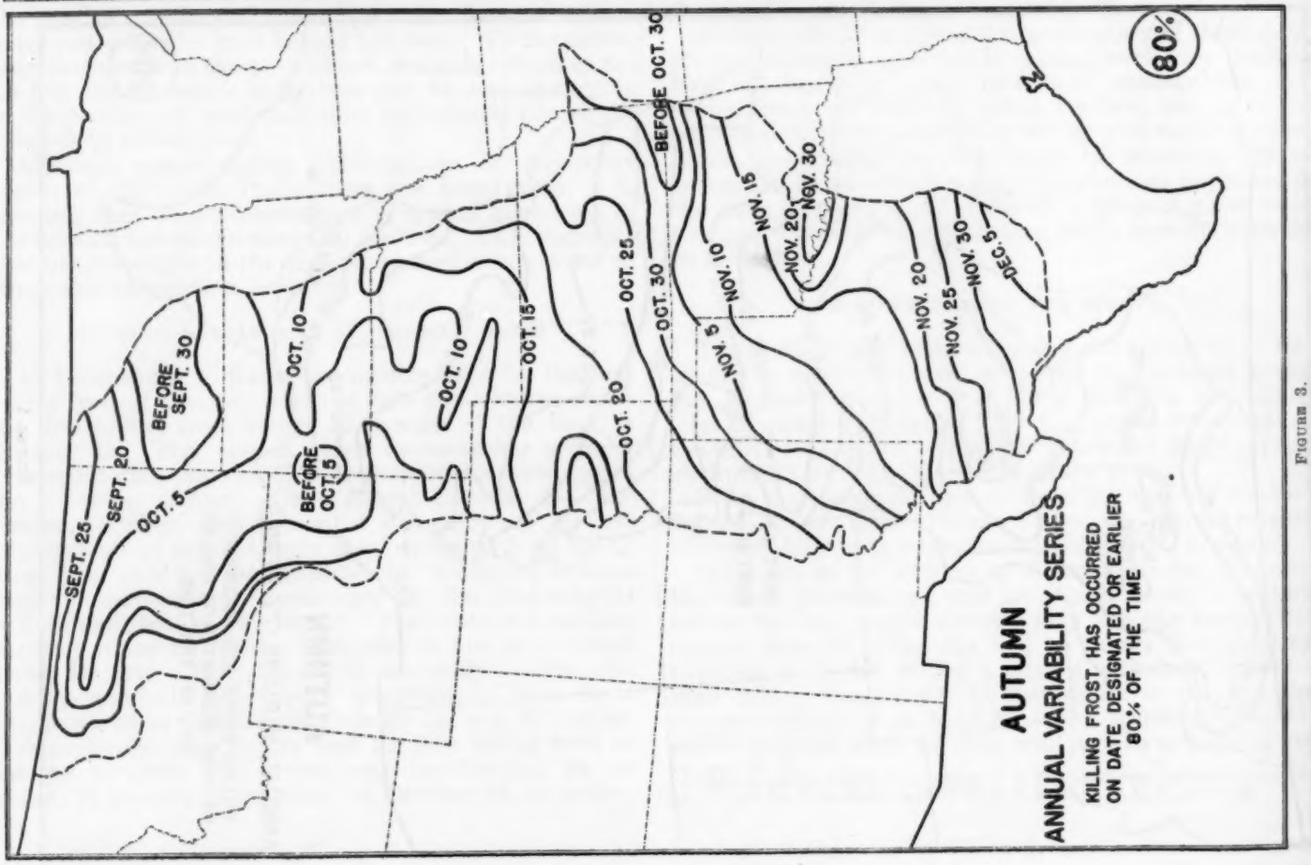
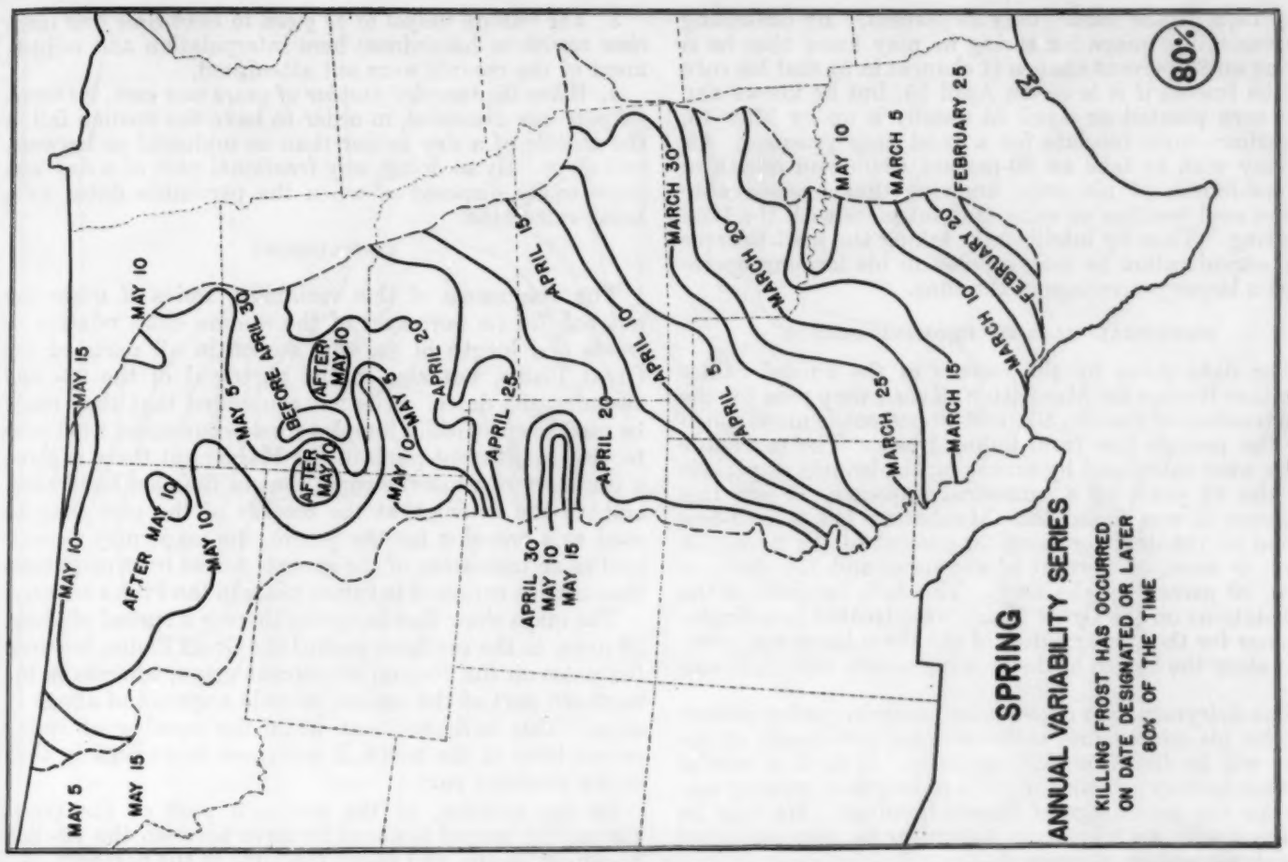


FIGURE 3.



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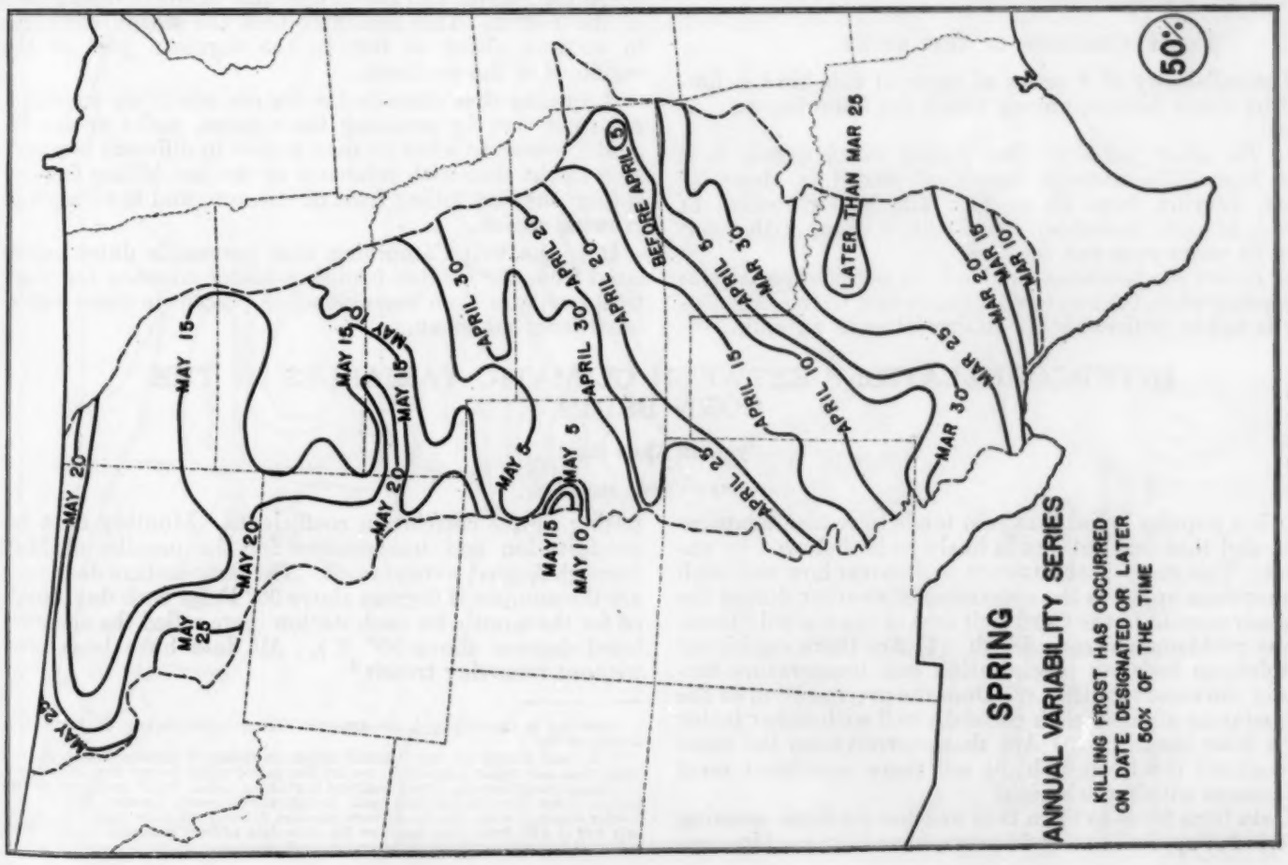

FIGURE 5.

May 13, with the hazard only 20 percent. By consulting the variability maps for spring he may know that he is taking an 80-percent chance (4 chances in 5) that his corn will be frosted if it is up on April 25; but he knows also that corn planted on April 25 usually is up by May 13, or earlier—none too late for a good crop prospect. Or he may wish to take an 80-percent chance on one-third or one-fourth of his crop, knowing that unseasonably dry or cool weather or rains may interfere with the later planting. Thus by intelligently taking the frost hazards into consideration he may succeed in his farming operations a larger percentage of the time.

ISOCRYMAL MAPS OF GROWING SEASON

The data given by the records of the United States Weather Bureau for Manhattan, Kans., were used for the construction of the 20-, 50-, and 80-percentile maps showing the periods free from killing frosts. The percentile dates were calculated by arranging the lengths of periods for the 43 years in a numerical sequence. From this sequence it was found that Manhattan has a frost-free period of 188 days, *or more*, 20 percent of the time, 174 days, *or more*, 50 percent of the time, and 154 days, *or more*, 80 percent of the time. The data for each of the 500 stations on the Great Plains were treated in a similar manner for the construction of the three isocrymal maps that show the length of the growing season (figs. 7, 8, and 9).

The dairyman who depends on forage crops for pasturage for his cows wants to know what percentage of the year will be free from killing frosts. If he is a careful planner he may consult the maps of length of growing season for the percentage of hazard involved. He may be satisfied with an 80-percent hazard or he may not want to risk more than 20 percent.

LIMITATIONS OF THIS STUDY

The reliability of a series of maps of this kind is limited by many factors, among which the following may be noted:

1. *The short period of time during which records have been kept.*—The average length of record is about 35 years, varying from 20 to 71. The longer record, of course, is more desirable. As a rule, stations with fewer than 20 years were not used.

2. *Errors in observation* are likely to occur, especially in the spring when the response of vegetation to freezing usually is not so noticeable nor so crucial as in autumn.

3. *The relative weight to be given to short-time and long-time records* is hazardous; here interpolation and adjustment of the records were not attempted.

4. *When the recorded number of years was even, the earliest year was discarded,* in order to have the median fall in the middle of a day rather than at midnight or between two days. By so doing, any fractional part of a day was more easily disposed of when the percentile dates were being calculated.

CONCLUSIONS

The uniqueness of this variability series of maps lies not only in its portrayal of the *median dates* relative to frosts and length of growing season in all parts of the Great Plains, but also in the portrayal of the 20- and 80-percentile dates. It is not contended that they could be used to specifically forecast frost occurrences from year to year in different parts of the Plains; but there is given a summary of what the conditions in the past have been, and, to the extent that the records of the past may be used as a criterion for the future, the maps may be utilized as an indication of the general run of frost conditions that may be expected in future years in the Plains country.

The maps show that in spring there is a spread of about 30 days, in the southern part of the Great Plains, between the dates on the 20- and 80-percent maps; whereas in the northern part of the region, there is a spread of about 15 days. This indicates that while the opening of spring occurs later in the north, it advances more rapidly than in the southern part.

In the autumn, in the southern part of the Great Plains, the spread is about 20 days between the 20- and 80-percent maps, and about the same in the northern part of the region. This indicates that the season advances in autumn about as fast in the northern part of the region as in the southern.

Assuming that climatic factors are relatively constant, a farmer can, by scanning these maps, make an intelligent guess as to what he may expect in different percentages of the time with reference to the last killing frost of spring, the first killing frost of autumn, and the length of growing season.

It is the writer's opinion that percentile dates calculated from the median furnish a better criterion for practical purposes than corresponding percentile dates calculated from the mean.

INTERCORRELATIONS BETWEEN CLIMATIC VARIABLES IN THE CORN BELT [1]

By JOHN KERR ROSE

[University of Chicago, March 1936]

It is a popular belief that rain tends to reduce temperature, and that one hot day is likely to be followed by another. This study is an attempt to discover how well such assumptions apply to the succession of weather during the summer months in the Corn Belt area of the United States. Three problems are considered: (1) Are there significant correlations between precipitation and temperature factors of the same month? (2) Does the precipitation or the temperature of one month correlate well with either factor for a later month? (3) Are these correlations the same throughout the Corn Belt, or are there significant areal differences within the region?

Data from 30 to 45 Corn Belt weather stations, covering a period of approximately 20 years, have been used in computing simple correlation coefficients. Monthly data for precipitation and temperature for the months of May through August were studied. The temperature data used are the number of degrees above 90° F. for each day, totaled for the month, for each station (here called the accumulated degrees above 90° F.). All data have been used without removing trends.[2]

---

[1] Presented at the meeting of the American Meteorological Society, St. Louis, Mo., December 1935.

[2] It is a well known fact that if secular trends are present in correlated data, spurious correlations may result merely from the fact that paired values deviate from their respective means partly because of their positions in the time series. Small trends are present in most of the climatological data used. Investigation showed, however, that the coefficients obtained when the trends were removed differed not more than 0.05, mostly only 0.02 or 0.01, from those based on the same data without removing trends. Such differences are not significant in the present problem.

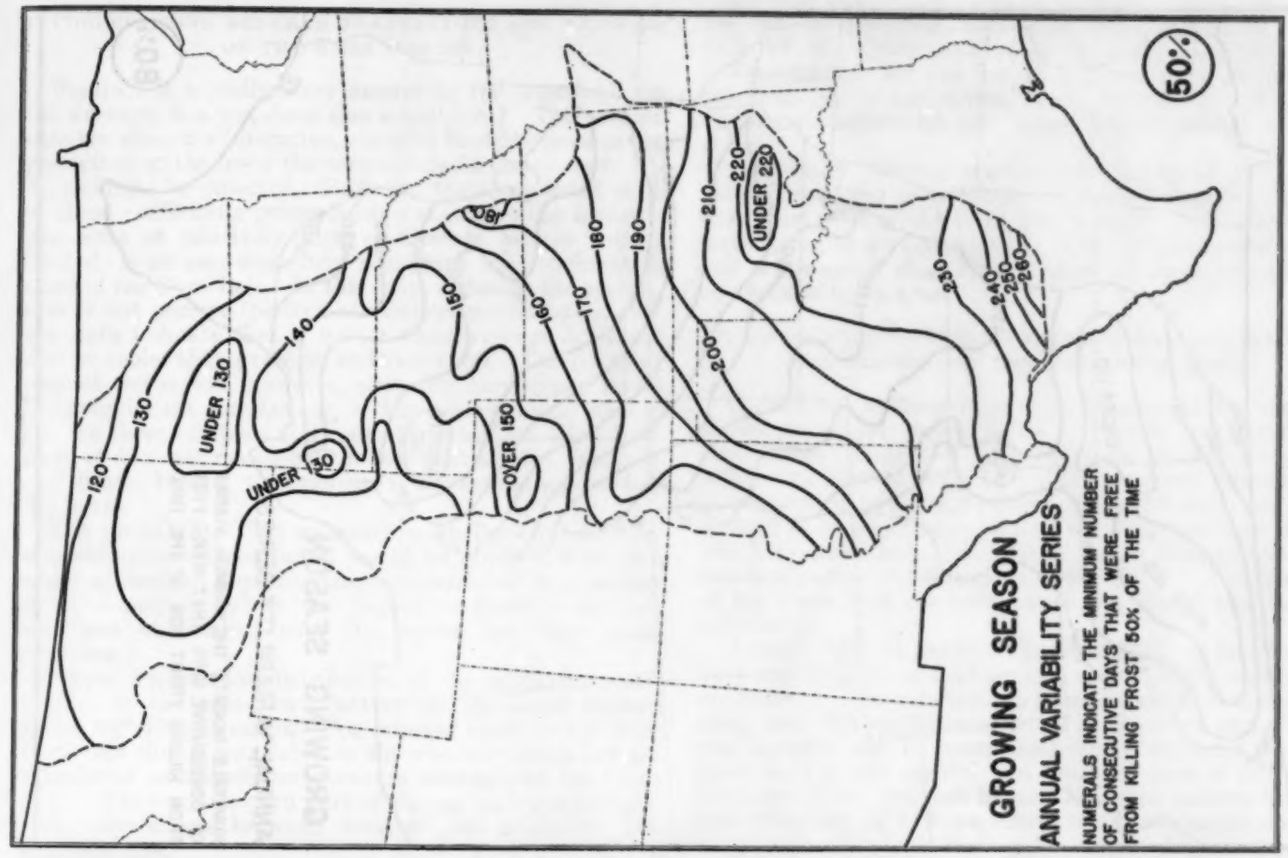

FIGURE 8.

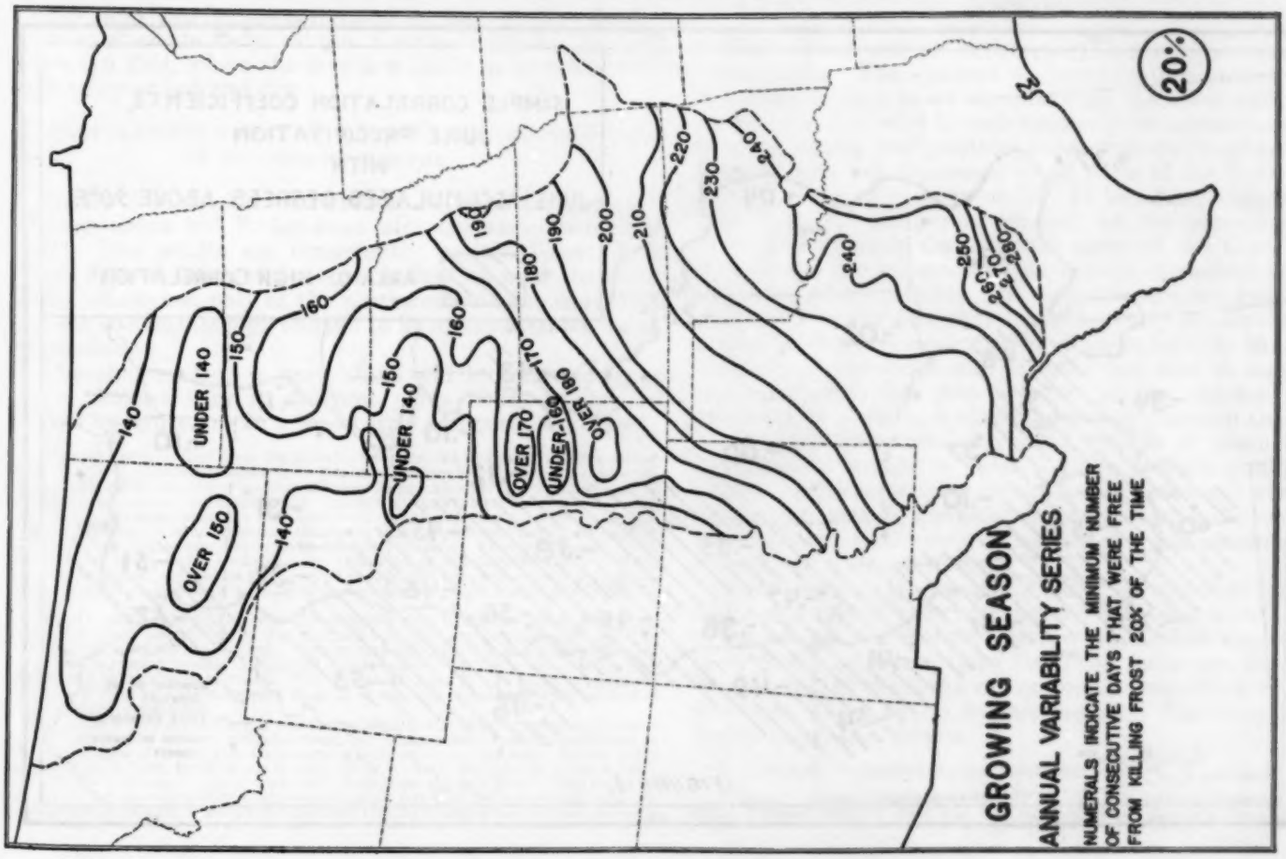

FIGURE 7.

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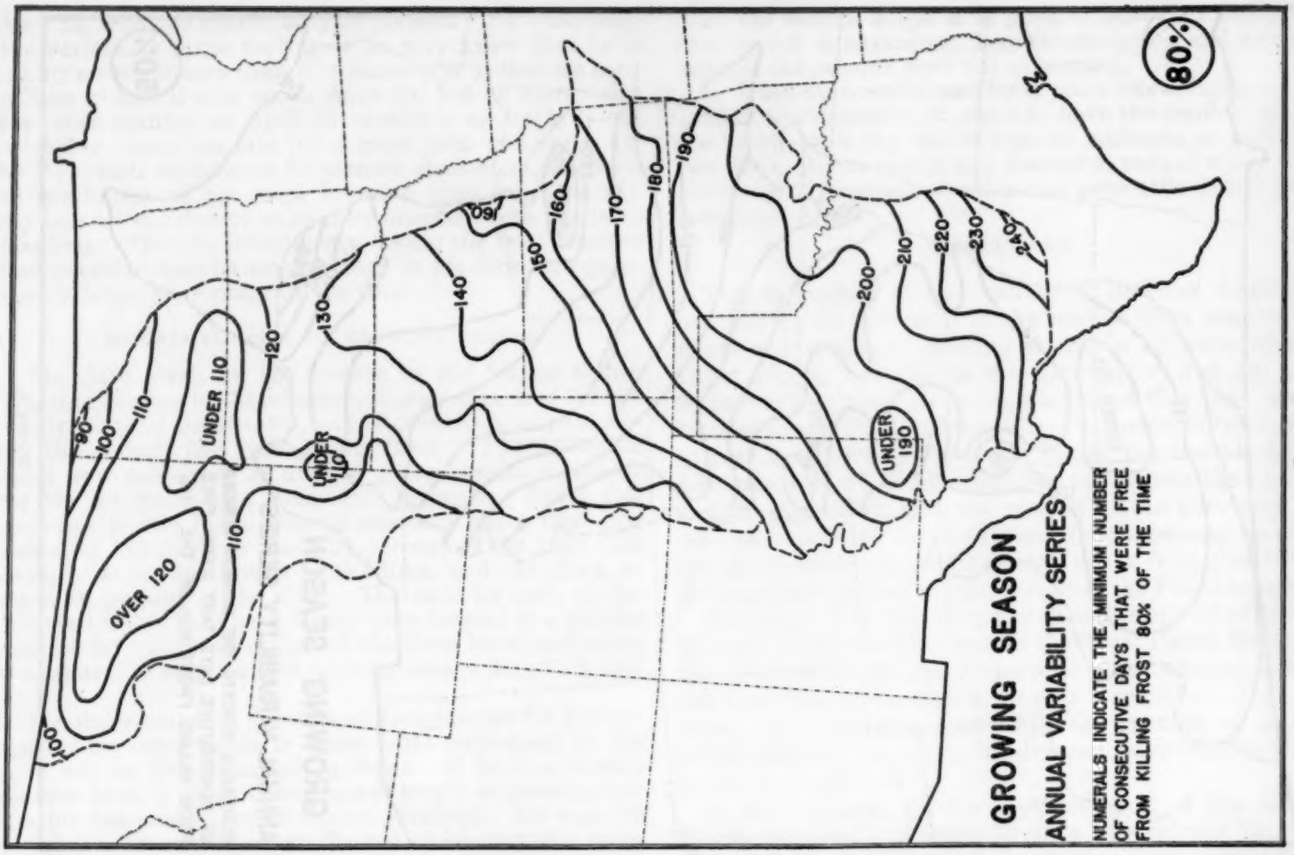


FIGURE 9.

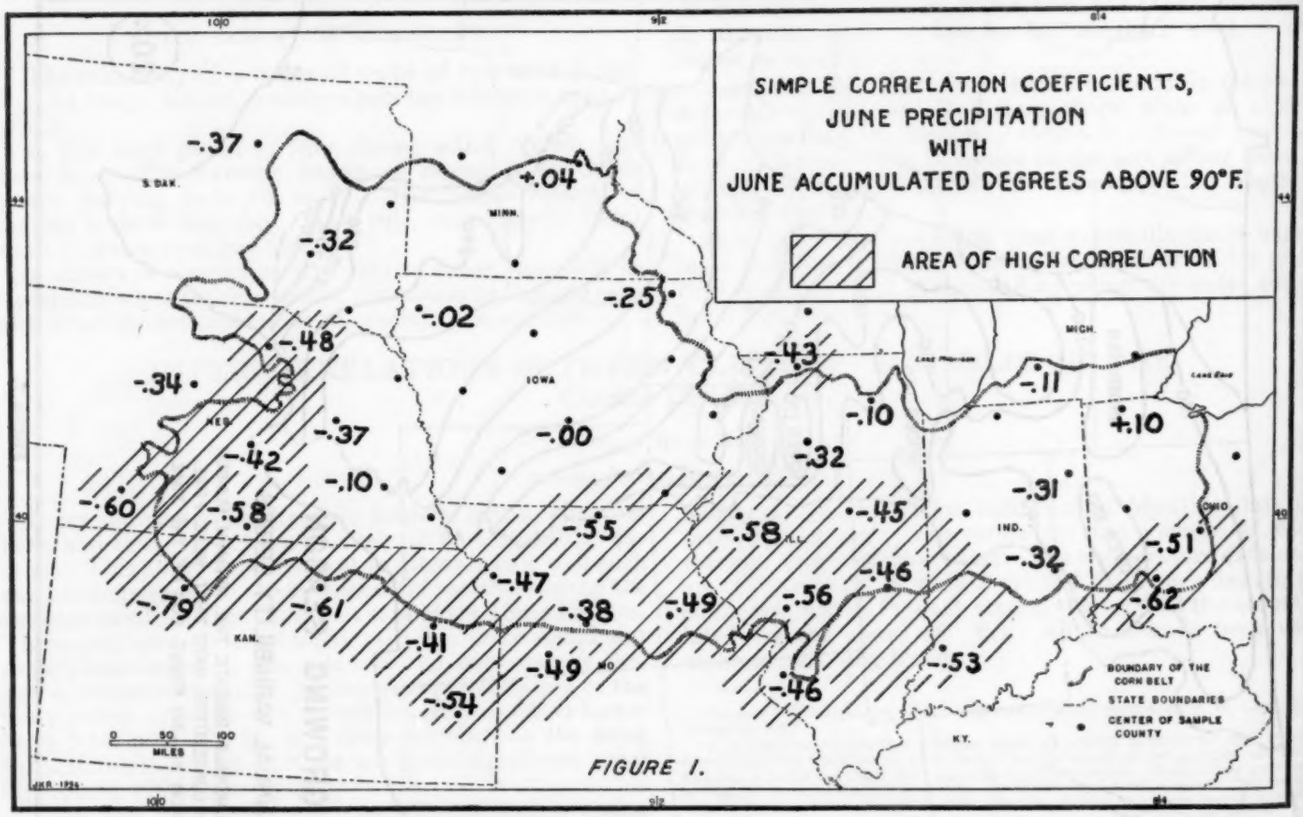


FIGURE 1.

I. CORRELATIONS BETWEEN TEMPERATURE AND RAINFALL OF THE SAME MONTHS

Figure 1 is a preliminary answer to the question: On the average, is a wet June also a hot June? The coefficients are almost all negative, showing that the greater the precipitation the fewer the accumulated degrees above 90° F., as might be expected. However, the areal distribution of these coefficients presents several interesting features. The area of relatively high coefficients (above −0.40, shaded) is an east-west strip occupying the southeastern third of the Corn Belt. In this strip, although the correlation is not perfect (perfect correlation would be ±1.00), the data indicate that a wetter than average June will also be cooler than average, and vice versa. The northern part of the region, however, with few exceptions, shows little significant correlation; and in central Iowa, none at all. In these northern and central parts of the Corn Belt, then, it does not necessarily follow that a rainy June is a cool June. Indeed, the opposite is the case in almost half the years.

The probability that so many coefficients of the considerable number computed would be above −0.40 as a result of random sampling from uncorrelated data is very small, especially when the higher coefficients are not scattered at random over the region but show areal grouping.[3]

Figure 2 shows the distribution of the correlation coefficients of the same two factors (accumulated degrees above 90° F. and rainfall) for selected stations for July. It reveals that a wet July, on the average, has a low accumulated maximum temperature throughout the Corn Belt. The southwestern part of the region has especially high correlations between wetness and relatively low temperatures.

The same two factors correlated for August show significant coefficients only in the Kansas-Nebraska part of the Corn Belt, where the month is likely to be either cool and rainy or hot and dry.

II. CORRELATIONS BETWEEN ACCUMULATED TEMPERATURES OF SUCCESSIVE MONTHS

Figure 3 shows the correlations between accumulated degrees above 90° F. for June with the same factor for July. The results are consistently positive—that is, a warm June is followed by a warm July all over the Corn Belt. However, only in the northwest and the southeast are the coefficients high enough to have considerable value in prediction.

The chances that a warm June will be followed by a warm August vary in different parts of the region, as shown by figure 4. In a broad strip across the southwest, the chances are great, with coefficients as high as +0.65 and +0.70. Over the rest of the Corn Belt, however, the coefficients are too low to indicate any considerable relation. In a few areas, there are slight indications (negative coefficients) that a cool August follows a warm June.

Correlation between accumulated degrees above 90° F. for July and the same factor for August (figure 5) shows that over most of the Corn Belt a warm July is likely to be followed by a warm August. Only in Kansas-Nebraska and a few small areas on the edges of the region are the coefficients indecisive.

III. CORRELATIONS BETWEEN MONTHLY RAINFALL AND THE TEMPERATURE OF THE FOLLOWING MONTH

Correlation of May rainfall with accumulated degrees above 90° F. for June (figure 6) reveals few significant coefficients. Only 8 of the 32 stations studied had coefficients as high as −0.40. In south-central Illinois and southwestern Indiana, however, the coefficients are high enough to be significant, so that one may conclude that a wet May tends to be followed by a cool June (with small totals of accumulated degrees above 90° F.). In the rest of the Corn Belt the correlations are mixed and largely indecisive.

A rainy July, on the other hand, is likely to be followed by a cool August, as indicated by the negative coefficients on figure 7. The relationship is consistent over the whole area, since the coefficients are all of the same sign; but a cool August can be most confidently expected after a rainy July in the central and southern part of the Corn Belt east of the Missouri River—including eastern Kansas and excluding all of Iowa except the southeastern corner.

SUMMARY

There is as yet no satisfactory explanation of these correlations. The concept of "temperature persistence" is helpful so long as we consider only the areas with high coefficients; but why is such tendency for continuation of drought, excess precipitation, subnormal and supernormal temperatures not evidenced in all parts of the Corn Belt instead of in only parts of it? It has been suggested [4] that data (for the period studied) on the percentage of time during which the different parts of the Corn Belt were under the influence of air masses of various origins might afford the solution, but such data are not available.

In spite of the fact that no satisfactory explanation is available, the enormous statistical improbability that the correlations are accidental, plus the fact that so many of the coefficients fall into a more or less regular areal grouping, or pattern, makes it practically certain that the correlations discovered are valid. Some of them have considerable predictive value. As to possible predictive utility, McEwen, writing on methods of seasonal weather forecasting, may be quoted: "It [correlation] is the method by which our trial forecasts were begun and continues to receive our main attention." [5]

In conclusion, the foregoing study reveals that rainfall and accumulated temperatures, of the same month and of successive months, correlate to significant extents in parts of the American Corn Belt; and moreover, that the distribution of the areas of significant correlation reveals problems which invite further research that may yield highly important results.

[3] The standard error (and hence the probable error, derived therefrom) has been shown by R. A. Fisher, "Statistical Methods for Research Workers," Fifth edition, to be notoriously unreliable for samples of less than 25 cases; hence such criteria of the significance of the coefficients are not used in this study. Instead, Fisher's tables (*ibid.*) have been used to ascertain (by considering the numerical value of the coefficient, and the number of paired values used in its computation) the chance that the coefficient could have resulted by accident of random sampling in an uncorrelated universe. Thus the selection of the value ±0.40, above which coefficients are considered as definitely significant (shaded areas on the maps), is based on the fact that there is only one chance in ten that a coefficient of ±0.40 could arise by accident of random sampling if correlation were not truly present.

The same tables show that if the coefficient is as high as ±0.45, the chance of its being accidental is only one in twenty; if as high as ±0.53, only one chance in fifty; and if as high as ±0.57, only one in a hundred. Thus an approximate evaluation of the coefficients on any of the maps is possible by applying the above tests and the theorem of compound probability for independent events. The probability that all of a set of independent events will occur on a given occasion when all of them are in question is the product of their separate probabilities.

Thus there is only approximately one chance in fifty raised to the twenty-sixth power (50^{26}) of securing, by accident of random sampling of uncorrelated data, the coefficients in the shaded areas of figure 1 from the number of trials shown on that map. For fig. 2 this chance is one in 100^{26}; for fig. 3, one in 100^{24}; for fig. 4, one in 100^{11}; for fig. 5, one in 100^{26}; for fig. 6, one in 10^{26}; and for fig. 7, one in 50^{26}. Even these high probabilities that the correlations are not accidental do not take account of the fact that the higher coefficients are not arranged at random over the map but show a striking tendency toward areal grouping.

[4] H. Landsberg, in discussion of paper at joint session of A. A. G. and A. M. S., St. Louis.

[5] George F. McEwen: "Methods of Seasonal Weather Forecasting at the Scripps Institution of Oceanography." Bull. Am. Met. Soc., vol. 15, no. 11, p. 251. Nov. 1934.

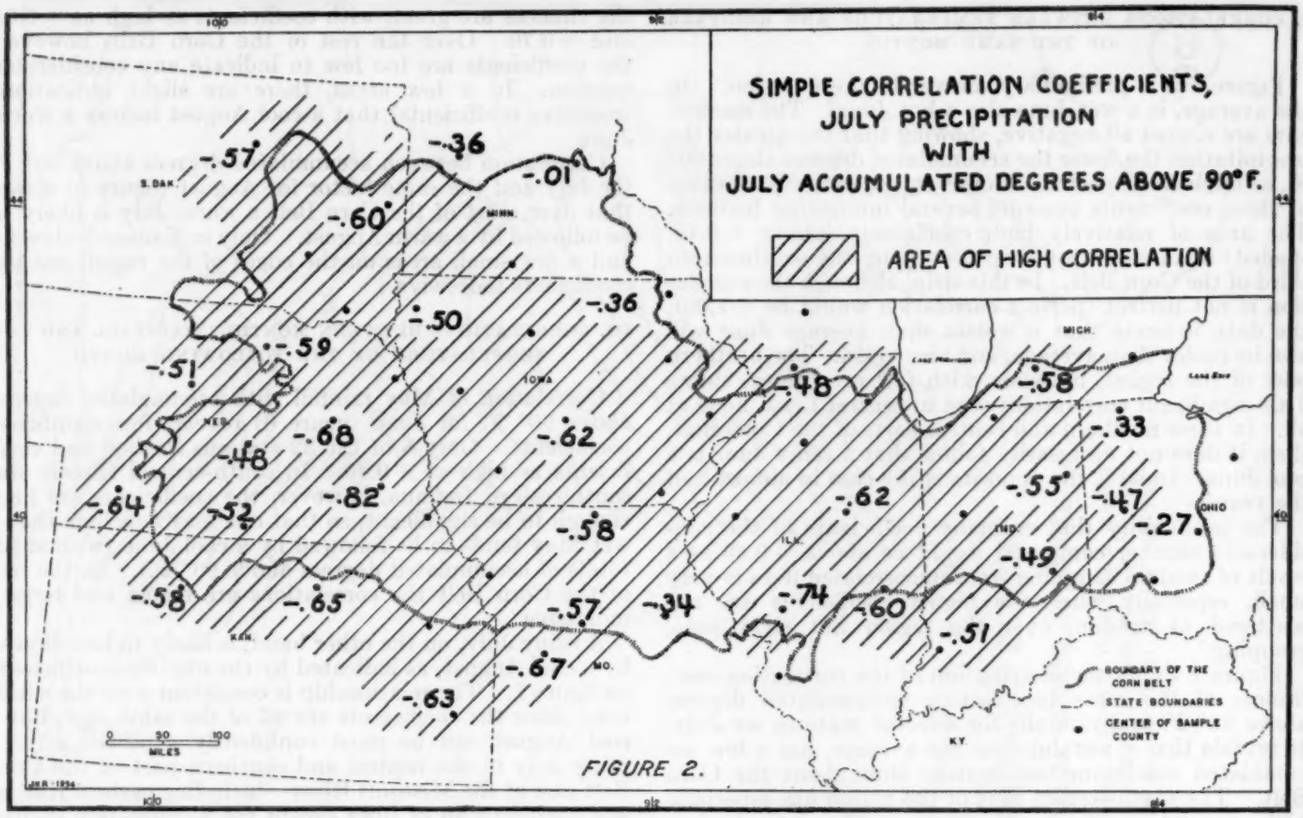


FIGURE 2.

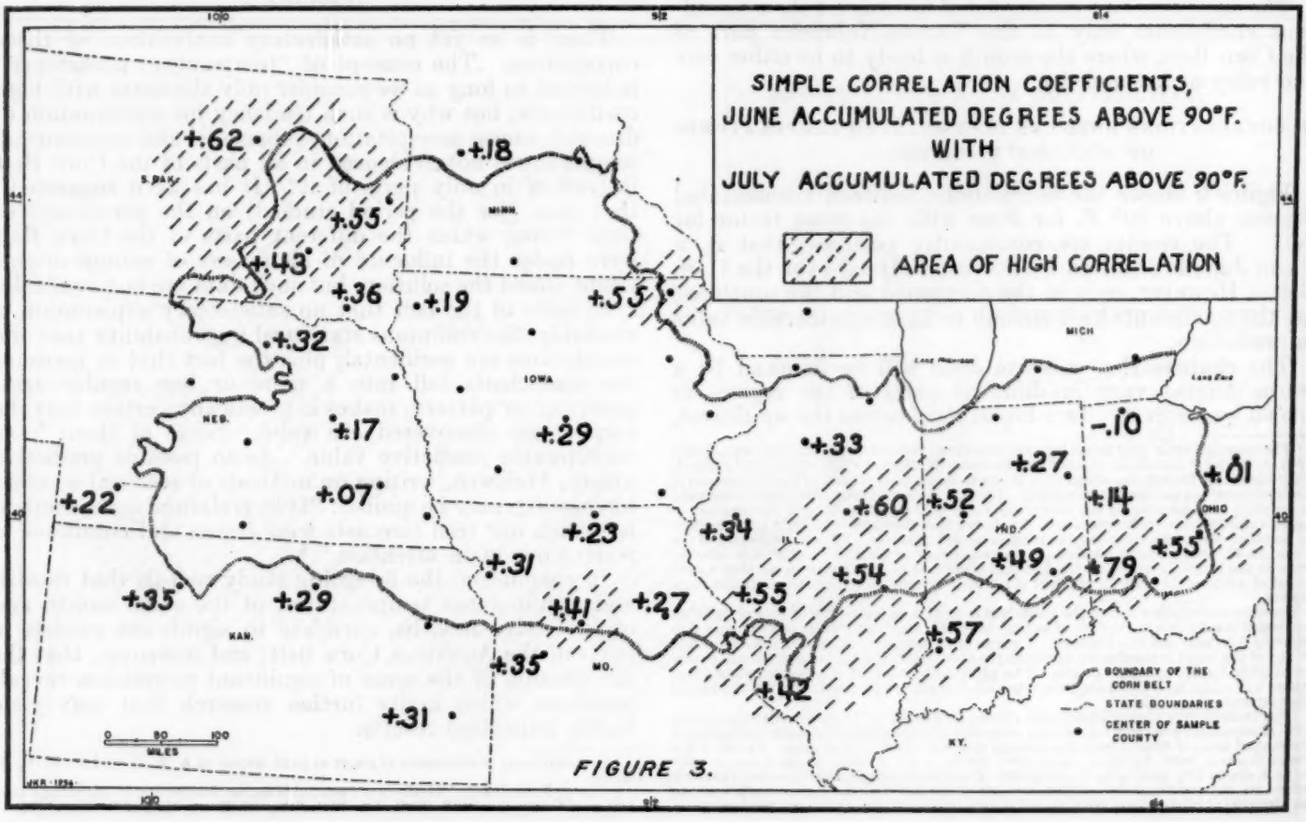


FIGURE 3.

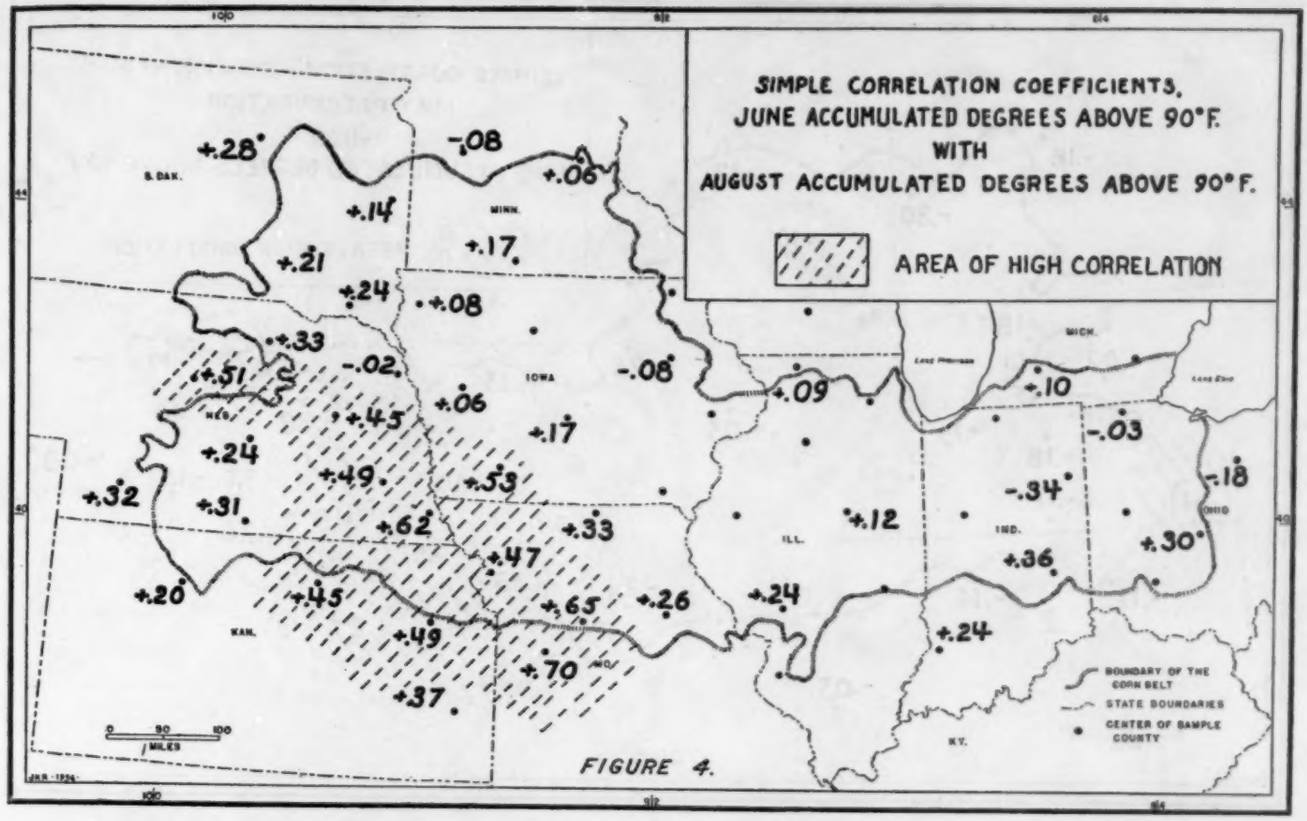


FIGURE 4.

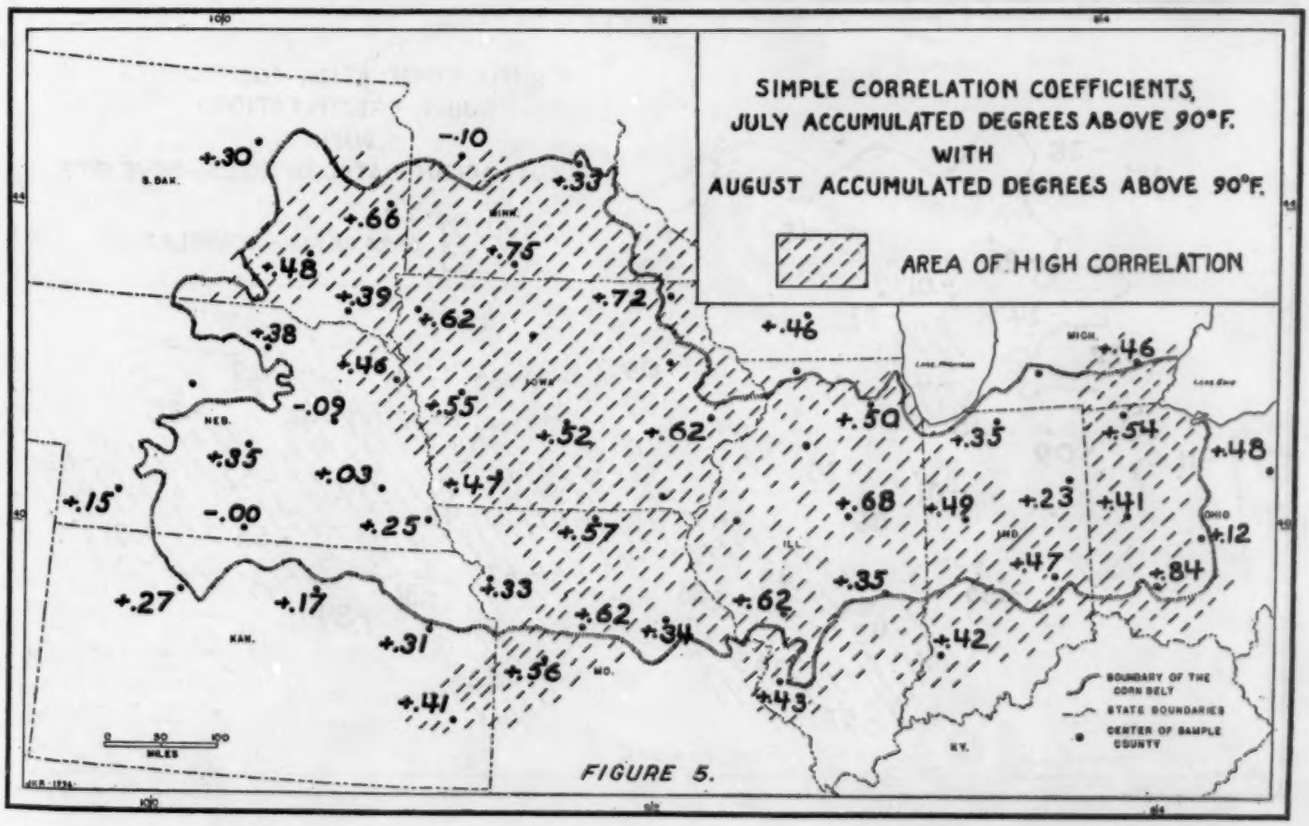


FIGURE 5.

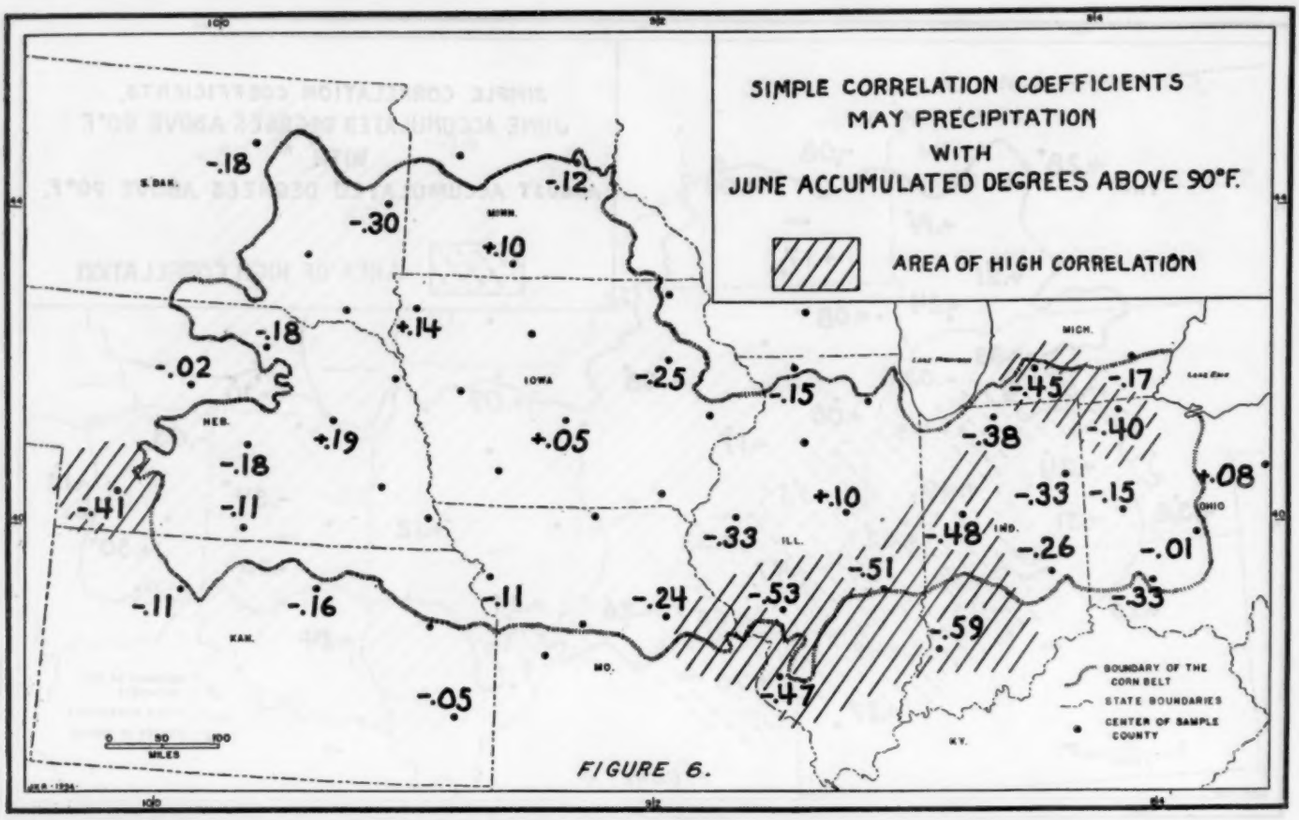


FIGURE 6.

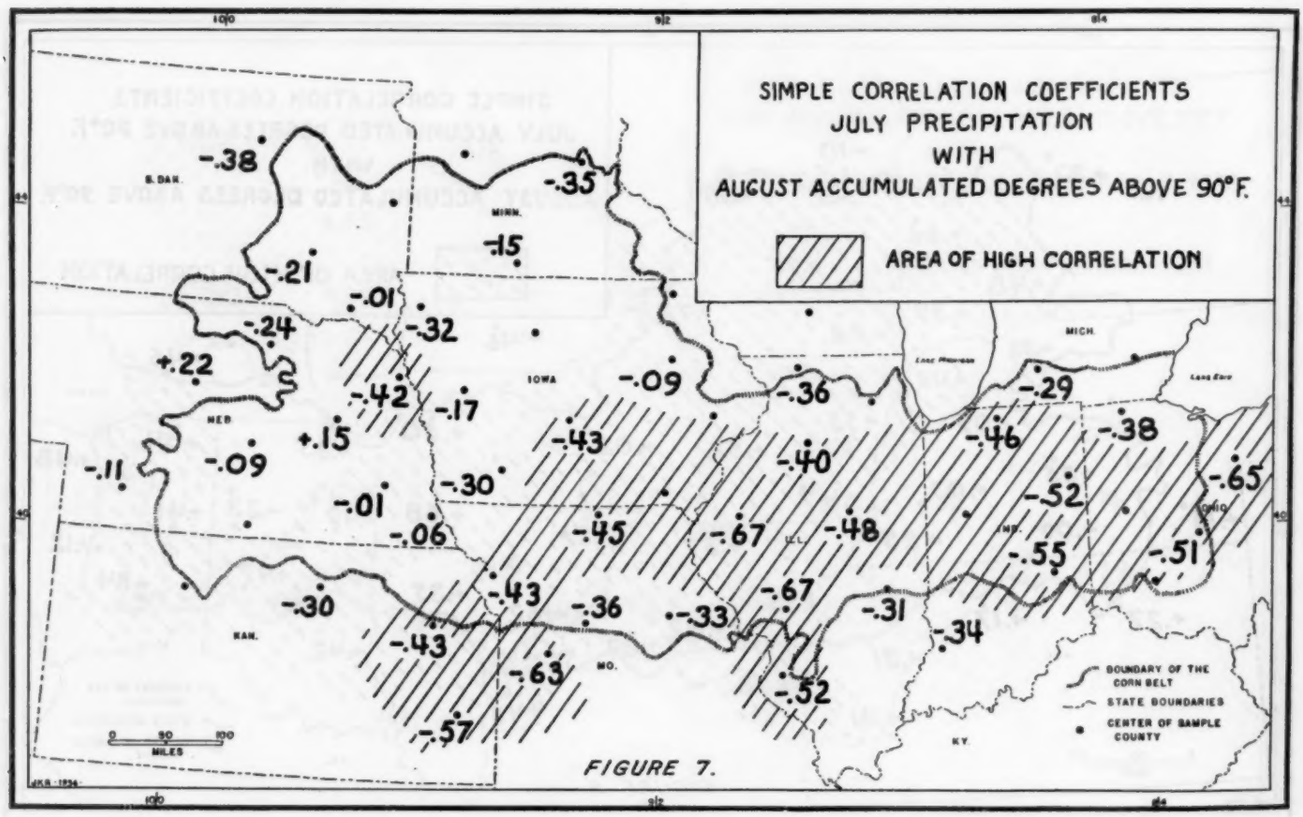


FIGURE 7.

FIGURE 1.—Group of ice crystals, 22 inches in diameter. The cluster near the center is shown in figure 2, and the large crystal just to the right is shown in figure 3. Boise Idaho, February 28, 1936; 8 a. m., f: 32, 20 seconds: camera inclined downward 30°.

FIGURE 2.—Crystal cluster, 6 inches in diameter.

FIGURE 3.—Ice crystal, 4¾ inches in diameter. Note the vertical triangular crystals in the upper right-hand corner. 8:10 a. m., f: 32, 13 seconds; inclination of camera, 30° downward.

AN OBSERVATION OF UNUSUAL ICE CRYSTALS

By C. ROBERT ELFORD

[Weather Bureau, Boise, Idaho, April 1936]

Ice crystals of unusual size were found on the morning of February 28, 1936, at Boise, Idaho, in what had been on the previous afternoon a shallow mud-puddle. The crystals were suspended one-quarter to one-half inch above black soil; the water below apparently had soaked into the ground.

The entire collection of crystals, shown in figure 1, was 22 inches in diameter, and consisted of a number of "stars", some alone and others in clusters. The largest individual "star", shown in figure 3, was 4¾ inches in diameter, while the others ranged downward to a very small size. The large cluster of crystals near the center of the group, shown in figure 2, was 6 inches in diameter. Scattered between the "stars" and the clusters, apparently without any regularity, were triangular-shaped crystals, all in vertical planes; these triangular crystals each extended downward from a vein along the upper edge, as shown in figures 1 and 3.

The temperature had fallen slowly during the night, from 35 degrees at midnight to a minimum of 31.6 at 7 a. m., and had risen to 32 by 8 a. m. at which time the pictures were taken. Wind during this period did not exceed 3 miles per hour at any time. The sky was overcast with alto-stratus until about 7:30 a. m., when it started to break, and by 8 a. m. only one-tenth alto-cumulus remained. The crystals were within 3 feet of a building to the south, and within 15 feet of buildings to the north and east, and were thus well sheltered from any disturbing influence.

In the photography of the crystals, a verichrome film pack was used in a 9 by 12 centimeter Kodak Recomar camera with a double-extension bellows. Since it was impossible to get advantageous lighting with a vertical shot, it was necessary to take the picture with the camera slanting downward about 30 degrees, and with the lens about 20 inches from the subject. It was then necessary to stop the lens down to f: 32 in order to get the proper depth of focus. The first picture, taken at 8 a. m. mountain standard time or 7:15 local mean time, was given 20 seconds in accordance with a photometer reading. The second picture, about 10 minutes later, took only 13 seconds; while the third, 10 minutes still later, required only 6 seconds. To the eye, the change in light between exposures was imperceptible, yet when the films were developed uniformly in the same tray their densities were almost exactly the same.

MONTHLY TEMPERATURES, 1925–35, AT THE MONTEZUMA STATION OF THE SMITHSONIAN INSTITUTION

By C. P. BUTLER

[Smithsonian Institution, Washington, D. C., April 1936]

The following tables contain the monthly mean and extreme temperatures recorded from 1925–35 at the Montezuma Station of the Astrophysical Observatory of the Smithsonian Institution, Calama, Chile. The daily records are on file at the Smithsonian Institution.

The station on Mount Montezuma is at longitude 68°56′ W., latitude 22°40′ S., and altitude 8,895 feet. The temperature data constitute an interesting example of a record at a high mountain station in a dry region.

TABLE 1.—*Monthly mean temperatures (centigrade)* $\left(\frac{maximum+minimum}{2}\right)$

Year	January	February	March	April	May	June	July	August	September	October	November	December	Mean	Highest	Lowest
1925	----	----	----	14.8	14.2	12.0	11.4	14.8	14.1	14.4	15.9	16.1	----	33.0	−1.0
1926	16.0	16.7	16.6	15.5	13.2	13.3	11.9	12.6	13.4	14.2	15.2	14.4	14.4	32.5	−2.0
1927	15.8	15.6	15.4	15.0	13.6	11.1	12.9	13.2	12.7	14.0	15.6	15.6	14.2	32.0	−3.5
1928	15.4	16.2	14.9	14.3	13.1	11.3	13.1	12.1	12.3	13.7	14.3	14.3	13.7	36.0	−10.0
1929	15.8	15.4	15.5	14.4	12.7	10.1	12.3	11.1	12.7	13.6	15.5	15.8	13.7	33.0	−3.5
1930	15.9	15.4	15.9	15.7	13.7	14.2	13.0	12.2	14.6	13.4	15.4	16.2	14.6	32.0	−3.0
1931	16.7	15.8	15.5	14.7	12.4	11.7	11.7	12.9	11.3	15.2	12.8	15.6	13.9	32.0	−5.5
1932	15.9	16.9	15.2	14.1	12.8	10.4	13.3	12.4	14.0	14.0	13.3	15.1	13.9	32.0	−4.5
1933	15.4	15.7	14.6	13.4	12.5	11.0	10.0	11.8	11.8	12.6	12.5	13.1	12.9	31.5	−3.0
1934	12.9	13.7	13.4	12.5	12.9	10.4	10.9	11.9	10.7	11.7	12.1	12.1	12.1	28.5	−4.5
1935	13.5	12.6	13.6	----	----	----	----	----	----	----	----	----	----	----	----

TABLE 2.—*Monthly maximum temperatures (extremes)*

Month	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
January	------	30.5	32.0	29.5	32.0	32.0	30.0	29.5	31.5	23.0	26.0
February	------	31.0	31.5	36.0	28.0	29.0	29.0	32.0	27.0	28.0	23.5
March	------	31.5	32.0	29.0	31.0	31.0	31.0	29.5	28.5	25.0	24.5
April	31.0	32.0	31.0	31.0	30.0	30.0	29.0	27.0	26.0	25.0	------
May	29.0	27.0	29.0	26.0	30.0	29.0	26.0	27.0	26.0	26.0	------
June	28.0	26.5	29.5	27.0	26.0	29.0	26.0	29.0	27.0	22.0	------
July	29.5	29.0	32.0	27.5	29.0	31.5	27.5	27.0	23.0	23.5	------
August	33.0	28.0	32.0	33.5	24.0	30.0	31.0	26.5	28.5	28.5	------
September	30.5	32.5	28.5	28.0	26.0	30.0	27.5	30.0	26.5	24.0	------
October	33.0	32.5	30.5	31.5	28.0	30.0	32.0	32.0	26.0	25.0	------
November	30.0	29.5	31.0	30.0	32.0	30.0	28.0	28.0	24.5	24.5	------
December	31.0	30.0	29.5	28.0	33.0	32.0	30.0	30.0	24.5	25.0	------
January	------	------	------	------	------	------	------	------	------	------	------

TABLE 3.—*Monthly minimum temperatures (extremes)*

Month	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
January	------	3.0	3.0	2.0	2.5	5.0	3.5	4.0	2.5	2.5	1.5
February	------	4.0	3.5	1.5	2.5	3.5	2.5	4.0	5.0	3.0	2.0
March	------	4.5	1.0	3.0	3.0	2.5	3.0	3.0	4.0	3.0	3.0
April	2.0	3.0	0.5	0.5	0.5	3.0	2.5	3.0	0.0	1.0	------
May	0.0	1.0	1.5	0.0	0.0	1.5	−5.5	1.0	1.0	1.0	------
June	0.0	0.0	−1.0	−0.5	−3.5	0.0	0.0	−4.5	−2.0	−1.0	------
July	−1.0	−2.0	−3.5	−10.0	−2.0	−3.0	−1.0	−3.0	−3.0	−4.5	------
August	−1.0	−1.0	−2.0	−9.5	−1.0	−3.0	0.0	−1.0	−1.0	−2.5	------
September	1.0	1.0	−2.0	0.5	−1.0	1.0	−1.0	−1.5	−0.5	−2.0	------
October	1.0	0.5	0.5	0.1	1.0	1.0	2.5	−1.0	−1.0	−1.0	------
November	2.0	1.0	1.0	0.5	1.0	3.0	−0.5	−1.0	0.0	−1.0	------
December	1.0	0.5	3.0	0.5	1.5	2.0	2.0	1.0	1.0	0.0	------

ERRATUM IN THE SMITHSONIAN METEOROLOGICAL TABLES: TEMPERATURE CORRECTION FACTOR IN THE HYPSOMETRIC FORMULA (ENGLISH MEASURES)

By V. E. JAKL

[Weather Bureau Airport Station, Chicago, Ill.]

The introduction to the Smithsonian Meteorological Tables, in dealing with the determination of heights by the barometer, using English measures, contains an erroneous mathematical transformation of the air-temperature term in the hypsometric formula, and hence the values for the temperature correction which are computed on the basis of this transformation are correspondingly discrepant to a slight degree. This error requires one of the tables, viz table 52 of the fourth and fifth editions, to be modified. To be specific, the tables in question contain the following statement (e. g., see p. xlii of the fourth edition, 1918, or p. xlvii of the fifth dition, 1931):

> In order to make the temperature correction as small as possible for average air temperatures, 50° F. will be taken as the temperature at which the correction factor is zero. This is accomplished by the following transformation:
>
> $1+0.002039(\theta-32°)=[1+0.002039(\theta-50°)][1+0.0010195\times 36°]$.

As may be easily verified, this is not an identity except when the mean temperature of the air column, θ, is equal to 50° F. The correct transformation is:

$$1+0.002039(\theta-32°)=[1+0.001967(\theta-50°)][1+0.0010195\times 36°].$$

This identity may be established by the following procedure:

Let $\alpha=0.002039$; then

$$1+\alpha(\theta-32)=1+\alpha(\theta-50)+18\alpha=(1+18\alpha)+\alpha(\theta-50).$$

Let a be a number such that

$$\alpha=\frac{a}{1-18a};$$

that is

$$\alpha=(1+18\alpha)a.$$

Substitute this value of α in the coefficient of $(\theta-50)$, whence we obtain

$$1+\alpha(\theta-32)=(1+18\alpha)+(1+18\alpha)a(\theta-50)=[1+18\alpha][1+a(\theta-50)].$$

Substituting numerical values, we get

$$a=\frac{\alpha}{1+18\alpha}=\frac{0.002039}{1+0.0367}=0.001967,$$

$$18\alpha=\frac{\alpha}{2}\cdot 36=0.0010195\times 36;$$

and these, when inserted in the expression last obtained, give the correct transformation as set forth above.

We may arrive at the same result by considering the steps leading to the hypsometric formula. Taking note of two facts: (1) That according to the gas laws, the thermal coefficient of expansion of air is equal to the reciprocal of the absolute temperature at which density (or volume) is regarded as standard, and (2) that the thermal coefficient of expansion of air which must be used in the temperature correction factor of the hypsometric formula should have a value appropriate to the temperature adopted for the (standard) density employed in the "barometric constant", it follows that if the (standard) densities employed in the "barometric constant" are based on the temperatures 32° F. or 50° F., respectively, the appropriate corresponding thermal coefficients of expansion of air are

$$\alpha=\frac{1}{491}=0.002039, \text{ very nearly, or}$$

$$a=\frac{1}{509}=0.001967, \text{ very nearly,}$$

respectively, since 491° and 509° are the absolute temperatures on the Fahrenheit scale equivalent to 32° and 50° F., respectively.

In the Smithsonian Meteorological Tables, the "barometric constant" for English measures is based on a temperature of 50° F. (see table 51 of the fourth and fifth editions), hence the latter coefficient is the appropriate one for the temperature correction factor.

In view of the above considerations, table 52 of the fourth and fifth editions of the tables in question, viz, Determination of Heights By The Barometer, English Measures, Term for Temperature: $0.002039(\theta-50°)Z$, should be modified to conform to the correct temperature term for these tables, viz $0.001967(\theta-50°)Z$. The following table, which was computed in the Aerological Division at the Central Office of the Weather Bureau, represents the result of applying the latter form of the correction:

TABLE 52.—*Determination of heights by the barometer, English measures*

Term for Temperature: 0.001967 ($\theta - 50°$) Z.

For temperatures {above 50° F. / below 50° F.} the values are to be {added / subtracted.

Mean temperature θ (° F.)		Approximate difference of height obtained from table 51												
		20	40	60	80	100	200	300	400	500	600	700	800	900
		Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet
49	51	0	0	0	0	0	0	1	1	1	1	1	2	2
48	52	0	0	0	0	0	1	1	2	2	2	3	3	4
47	53	0	0	0	0	1	1	2	2	3	4	4	5	5
46	54	0	0	0	1	1	2	2	3	4	5	6	6	7
45	55	0	0	1	1	1	2	3	4	5	6	7	8	9
44	56	0	0	1	1	1	2	4	5	6	7	8	9	11
43	57	0	1	1	1	1	3	4	6	7	8	10	11	12
42	58	0	1	1	1	2	3	5	6	8	9	11	13	14
41	59	0	1	1	1	2	4	5	7	9	11	12	14	16
40	60	0	1	1	2	2	4	6	8	10	12	14	16	18
39	61	0	1	1	2	2	4	6	9	11	13	15	17	19
38	62	0	1	1	2	2	5	7	9	12	14	17	19	21
37	63	1	1	2	2	3	5	8	10	13	15	18	20	23
36	64	1	1	2	2	3	6	8	11	14	17	19	22	25
35	65	1	1	2	2	3	6	9	12	15	18	21	24	27
34	66	1	1	2	3	3	6	9	13	16	19	22	25	28
33	67	1	1	2	3	3	7	10	13	17	20	23	27	30
32	68	1	1	2	3	4	7	11	14	18	21	25	28	32
31	69	1	1	2	3	4	7	11	15	19	22	26	30	34
30	70	1	2	2	3	4	8	12	16	20	24	28	31	35
29	71	1	2	2	3	4	8	12	17	21	25	29	33	37
28	72	1	2	3	3	4	9	13	17	22	26	30	35	39
27	73	1	2	3	4	5	9	14	18	23	27	32	36	41
26	74	1	2	3	4	5	9	14	19	24	28	33	38	42
25	75	1	2	3	4	5	10	15	20	25	30	34	39	44
24	76	1	2	3	4	5	10	15	20	26	31	36	41	46
23	77	1	2	3	4	5	11	16	21	27	32	37	42	48
22	78	1	2	3	4	6	11	17	22	28	33	39	44	50
21	79	1	2	3	5	6	11	17	23	29	34	40	46	51
20	80	1	2	4	5	6	12	18	24	30	35	41	47	53
19	81	1	2	4	5	6	12	18	24	30	37	43	49	55
18	82	1	3	4	5	6	13	19	25	31	38	44	50	57
17	83	1	3	4	5	6	13	19	26	32	39	45	52	58
16	84	1	3	4	5	7	13	20	27	33	40	47	54	60
15	85	1	3	4	6	7	14	21	28	34	41	48	55	62
14	86	1	3	4	6	7	14	21	28	35	42	50	57	64
13	87	1	3	4	6	7	15	22	29	36	44	51	58	66
12	88	1	3	4	6	7	15	22	30	37	45	52	60	67
11	89	2	3	5	6	8	15	23	31	38	46	54	61	69
10	90	2	3	5	6	8	16	24	31	39	47	55	63	71
9	91	2	3	5	6	8	16	24	32	40	48	56	65	73
8	92	2	3	5	7	8	17	25	33	41	50	58	66	74
7	93	2	3	5	7	8	17	25	34	42	51	59	68	76
6	94	2	3	5	7	9	17	26	35	43	52	61	69	78
5	95	2	4	5	7	9	18	27	35	44	53	62	71	80
4	96	2	4	5	7	9	18	27	36	45	54	63	72	81
3	97	2	4	6	7	9	18	28	37	46	55	65	74	83
2	98	2	4	6	8	9	19	28	38	47	57	66	76	85
1	99	2	4	6	8	10	19	29	39	48	58	67	77	87
0	100	2	4	6	8	10	20	30	39	49	59	69	79	89

TABLE 52.—*Determination of heights by the barometer, English measures*—Continued

Term for Temperature: 0.001967 ($\theta - 50°$) Z.

For temperatures {above 50° F. / below 50° F.} the values are to be {added / subtracted.

Mean temperature θ (° F.)		Approximate difference of height obtained from table 51										
		1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000	20,000
		Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet
49	51	2	4	6	8	10	12	14	16	18	20	39
48	52	4	8	12	16	20	24	28	31	35	39	79
47	53	6	12	18	24	30	35	41	47	53	59	118
46	54	8	16	24	31	39	47	55	63	71	79	157
45	55	10	20	30	39	49	59	69	79	89	98	197
44	56	12	24	35	47	59	71	83	94	106	118	236
43	57	14	28	41	55	69	83	96	110	124	138	275
42	58	16	31	47	63	79	94	110	126	142	157	315
41	59	18	35	53	71	89	106	124	142	159	177	354
40	60	20	39	59	79	98	118	138	157	177	197	393
39	61	22	43	65	87	108	130	151	173	195	216	433
38	62	24	47	71	94	118	142	165	189	212	236	472
37	63	26	51	77	102	128	153	179	205	230	256	511
36	64	28	55	83	110	138	165	193	220	248	275	551
35	65	30	59	89	118	148	177	207	236	266	295	590
34	66	31	63	94	126	157	189	220	252	283	315	629
33	67	33	67	100	134	167	201	234	268	301	334	669
32	68	35	71	106	142	177	212	248	283	319	354	708
31	69	37	75	112	149	187	224	262	299	336	374	747
30	70	39	79	118	157	197	236	275	315	354	393	787
29	71	41	83	124	165	207	248	289	330	372	413	826
28	72	43	87	130	173	216	260	303	346	389	433	865
27	73	45	90	136	181	226	271	317	362	407	452	905
26	74	47	94	142	189	236	283	330	378	425	472	944
25	75	49	98	148	197	246	295	344	393	443	492	984
24	76	51	102	153	205	256	307	358	409	460	511	1,023
23	77	53	106	159	212	266	319	372	425	478	531	1,062
22	78	55	110	165	220	275	330	386	441	496	551	1,102
21	79	57	114	171	228	285	342	399	456	513	570	1,141
20	80	59	118	177	236	295	354	413	472	531	590	1,180
19	81	61	122	183	244	305	366	427	488	549	610	1,220
18	82	63	126	189	252	315	378	441	504	566	629	1,259
17	83	65	130	195	260	325	389	454	519	584	649	1,298
16	84	67	134	201	268	334	401	468	535	602	669	1,338
15	85	69	138	207	275	344	413	482	551	620	688	1,377
14	86	71	142	212	283	354	425	496	566	637	708	1,416
13	87	73	146	218	291	364	437	509	583	655	728	1,456
12	88	75	149	224	299	374	448	523	598	673	747	1,495
11	89	77	153	230	307	384	460	537	614	690	767	1,534
10	90	79	157	236	315	393	472	551	629	708	787	1,574
9	91	81	161	242	323	403	484	565	645	726	806	1,613
8	92	83	165	248	330	413	496	578	661	744	826	1,652
7	93	85	169	254	338	423	507	592	677	761	846	1,692
6	94	87	173	260	346	433	519	606	692	779	865	1,731
5	95	89	177	266	354	443	531	620	708	797	885	1,770
4	96	90	181	271	362	452	543	633	724	814	905	1,810
3	97	92	185	277	370	462	555	647	740	832	924	1,849
2	98	94	189	283	378	472	566	661	755	850	944	1,888
1	99	96	193	289	386	482	578	675	771	867	964	1,928
0	100	98	197	295	393	492	590	688	787	885	984	1,967

The differences between the original table 52 and the modified table herein are exemplified by the following tabulation for Z=5,000 feet:

θ (° F.)	$0.002039(\theta - 50°)Z$	$0.001967(\theta - 50°)Z$
50	0	0
60	102	98
70	204	197
80	306	295
90	408	393

The differences are thus obviously not very great under average conditions.

66169—36——3

COMPOSITION AND ORIGIN OF DUST IN THE FALL OF BROWN SNOW, NEW HAMPSHIRE AND VERMONT, FEBRUARY 24, 1936

By W. O. ROBINSON

[Bureau of Chemistry and Soils, Washington, D. C., April 1936]

During the night of February 24 and early morning of February 25, 1936, rain, sleet, and snow fell over the region of New Hampshire, Vermont, and northern New York; and at many localities the precipitation was strongly colored brown by admixed dust particles.[1]

Several samples of the dust were submitted to the Bureau of Chemistry and Soils: R. P. Haywood of Keene, N. H., was asked to gather and melt the snow that contained the brown dust and to evaporate the water to obtain the sediment. He kindly did this and sent the samples, but the quantity was too small to permit anything except microscopical examination and certain qualitative tests. Simultaneously with the receipt of Mr. Haywood's sample, two others collected from the same fall of snow were sent in by the Weather Bureau. One of these was from Wells River, Vt., sent by Wendell P. Smith, and the other from Peterboro, N. H., sent by C. L. Whittle. Mr. Smith's sample weighed about a gram and was large enough to permit of the following mechanical analysis by T. M. Shaw of the Bureau of Chemistry and Soils:

	Percent
Larger than 50μ	2.2
Between 50 and 20μ	.7
Between 20 and 10.7μ	28.4
Between 10.7 and 6.6μ	27.6
Between 6.6 and 5.0μ	7.7
Between 5.0 and 3.1μ	18.8
Between 3.1 and 2.0μ	9.2
Less than 2.0μ	5.4

I. C. Brown of the same Bureau reports the following results of mineralogical examination:

1. *Silt of Wells River, Vt., sample.*—Quartz abundant; biotite, opaline material, iron oxide present; few feldspars; organic matter abundant.

2. *Entire quantity, Peterboro. N. H., sample.*—Quartz and feldspars abundant; tourmaline and hypersthene present; also opaline material and silicified organic material characteristic of midwestern soil material. Soil material comparatively undecomposed.

3. *Entire quantity of Keene, N. H., sample.*—Quartz and feldspars abundant; titanite and rutile scarce; opaline and silicified organic remains characteristic of midwestern soils; soil minerals comparatively undecomposed.

Samples 2 and 3 resemble each other closely; the particles are largely of colloidal size. The Wells River sample is comparatively coarse and contains relatively small quantities of colloidal matter (less than 2 μ). It would appear that the meteorological conditions operating caused an air elutriation or mechanical separation of the particles present in the original dust storm, with the result that the larger particles settled around Wells River and the finer particles at Keene and Peterboro. The fall in St. Johnsbury, Vt., was estimated at 10 tons to the square mile. The fall at Keene, N. H. was apparently very much lighter.

The colloidal matter separated from the Wells River sample was analyzed, with the following results:

	Percent
SiO_2	48.9
Al_2O_3	20.4
Fe_2O_3	6.1
CaO	5.4
MgO	3.2
Loss on ignition and undetermined	16.0

The molecular ratio $\frac{SiO_2}{Al_2O_3+Fe_2O_3}$ of soil colloids is a distinguishing soil characteristic, and this ratio varies from above 4 in the pedocals of the west to less than 1 in the lateritic soils of the South. Byers, Alexander, and Holmes (U. S. D. A. Tech. Bul. 484) give a full discussion of the significance of this ratio as differentiating the soils of the various soil groups.

The $\frac{SiO_2}{Al_2O_3+Fe_2O_3}$ ratio of the colloid of the Wells River sample is 3.3. This fact, combined with the high content of lime and the presence of calcium carbonate in all three samples, makes it almost certain that the dust deposited in the storm orginated no farther east than the Missouri River.

The Peterboro sample gave 15.0 percent loss on ignition.

On the basis of an estimated fall of 10 tons to the square mile at St. Johnsbury, Vt., the quantity of elements useful to plants that is transferred by these dust storms is of considerable importance. Qualitative examination of the coarser particles of the Wells River sample indicated that the coarser fractions contain fully as much lime as the colloidal fraction. Assuming that the whole mass of dust contained 5.3 percent CaO, than a fall of 10 tons would enrich a square mile by 1,060 pounds of lime.

[1] See, e. g., H. I. Baldwin, The Fall of Brown Snow in New Hampshire, Science, Apr. 17, 1936, p. 371.

METEOROLOGICAL HISTORY OF THE BROWN SNOWFALL OF FEBRUARY 1936

By HORACE R. BYERS

[Weather Bureau, Washington, D. C., April 1936]

The trajectory of the dust-laden air that was involved in this storm may easily be traced back to the "dust bowl" in the neighboring parts of the five States, Colorado, New Mexico, Texas, Oklahoma, and Kansas. An examination of the pilot-balloon observations and the displacements of the pressure systems shows that the air reaching northern New England on the night of February 24–25 started from the above-mentioned area on February 23, at a time when severe dust storms occurred there.

An almost steady current of air from the dust-source region to New England prevailed from February 23 to 25. When the velocities of the wind, which were of the order of magnitude of 50 to 60 miles per hour, are considered, the movement of this air from the vicinity of the Texas Panhandle on February 23 to New England on the 25th is easily accounted for. Air at Amarillo, Tex., at 5 p. m. eastern time on February 23 would have reached central Iowa 12 hours later, would have passed over the

lower Great Lakes during the day and reached the vicinity of Buffalo at 5 p. m. on the 24th. This motion would carry the air to New Hampshire by about midnight. The path indicated goes northeastward through Iowa, and gradually curves eastward over the Lower Great Lakes region, approaching New England from west-northwest.

This path is verified by observational evidence of dustfalls. Dust was observed to spread over central Kansas and aloft over the eastern portion of that State on the 24th, appearing at high levels even at North Platte, Nebr. During the airplane observation at Omaha, begun at 4 a. m. on the 24th, dust was observed between 2,230 and 3,430 meters. From that station eastward to Buffalo, no observation of the dust was noted, because general cloudiness prevailed without precipitation; and the obscuring effect of the dust, which at this time was only aloft, could not be distinguished from that of the clouds. The dust became apparent in northern New York when rain which had mixed with the dust to produce mud was observed.

The conditions in the "dust bowl" on February 23 when this dust began to be raised are described in the report of Glen H. Phillips, Weather Bureau observer at Pueblo, Colo. He writes:

> Black, swirling clouds of dust rolled over practically every county [in Colorado] south of the 40th parallel and east of the 105th meridian. The air was heavily laden with dust over this area, reducing the visibility to practically nothing in many localities and completely halting motor traffic. Pueblo experienced the worst storm since the St. Patrick's Day "black blizzard" of 13 years ago. Semidarkness enveloped the entire southeastern portion of the State and artificial light was used during midday.

Similar conditions were reported in western Oklahoma, the Texas Panhandle, northeastern New Mexico, and at Dodge City, Kans.

The reports from northern New York give an interesting account of how the dust was precipitated late the following day out of the upper air along with the raindrops. At Buffalo, light dust had been observed in the afternoon by airplane pilots, who reported it as occupying a layer between 6,000 and 10,000 feet altitude. In the evening, between 7 and 8:15 p. m., the dust was brought down with a misting rain, which produced a thin coating of mud visible on polished objects such as automobiles. At Oswego, at 5:30 p. m. the sky was darkened by heavy clouds of a yellow color. Breaking of the clouds shortly after sunset showed the yellow color quite prominently. Subsequently reports were received of a small deposit of dust on automobiles which had been out between 5 and 7 p. m. The dust was reported at the following stations in the vicinity: Watertown, Tupper Lake, Alexandria Bay, and Willsboro.

At Canton, N. Y., there was a light fall of dust with the rain which occurred late in the afternoon and in the evening. H. E. Heyer, Weather Bureau official at Canton, writes:

> Motorists report that the windshields of their cars became so heavily streaked with mud as to interfere seriously with vision, making it necessary, in some cases, to stop and clean off the mud deposit.

The dust-laden air from the southwest was acting along a warm front against a colder air mass to the east. Over northern New England the air rising upward along the sloping warm front surface had reached a height such that snow was formed instead of rain. This snow showed the presence of dust just as had the falling rain. Falling with the snow, the dust produced a striking effect in the peculiar brown color it gave to the snow.

DUSTSTORMS OF FEBRUARY AND MARCH 1936 IN THE UNITED STATES

By R. J. MARTIN

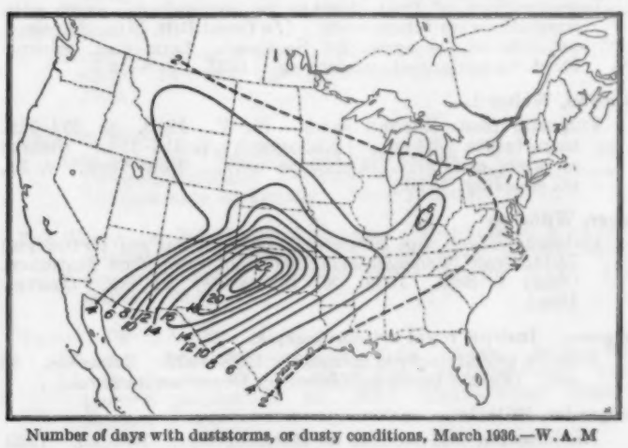
[Weather Bureau, Washington, D. C., April 1936]

The *Weekly Weather and Crop Bulletin* for the week ending February 4, 1936, carried the following statement: "The soil continues much too dry in the southwestern Plains, centering in southwestern Kansas and southeastern Colorado, with strong probability of drifting and duststorms unless more moisture is received soon."

Moisture sufficient to relieve the droughty conditions failed to materialize; and numerous and severe duststorms occurred over southeastern Colorado, northeastern New Mexico, western Kansas, and western Oklahoma in February. Late in the month, dust was reported as far east as Missouri, and some cooperative observers in Texas reported crop damage. In western, and some central, sections of Kansas the storms were of marked intensity; and on the 22d, visibility was so reduced by dust in portions of Colorado that pedestrians collided with one another in attempting to get about during the height of the storm. On the 24th, dusty conditions prevailed in portions of northern New York. These last two storms are described in the February 1936 MONTHLY WEATHER REVIEW.

The accompanying chart shows the number of days with duststorms or dusty conditions in March 1936, and is based only on reports from first-order stations of the Weather Bureau. It will be seen that the greatest number occurred in the persistently dry area centering over the Southern Great Plains, the frequency decreasing rather uniformly with distance from this droughty source—the "Dust Bowl."

Early in March, duststorms were reported in eastern New Mexico, where conditions were more favorable for their inception than in the preceding year, and in most



Number of days with duststorms, or dusty conditions, March 1936.—W. A. M

other sections of the dry southwestern area, especially in the Oklahoma Panhandle and southeastern Colorado. During the week ending March 24 severe storms, some of them the worst reported so far this year, occurred in several southwestern States. Dust from western Kansas was carried through the air to the eastern part of the State, but here the storms were not so severe as those of March

of the preceding year. At St. Joseph, Mo., visibility was reduced to one-fifth mile on the 23d; and on the following day similar conditions prevailed at Memphis, Tenn. At Davenport, Iowa, on the 24th visibility was reduced to 200 yards.

The Southwest remained dry as the month ended, with severe and extensive duststorms reported during the closing week, and in the Pacific Northwest storms blew out some spring-seeded wheat on light lands. As far east as Portland, Maine, dust from the western area was noted on several days; and on the 9th and 11th, a yellowish tinge to snow was noted generally over New England.

The *Weekly Weather and Crop Bulletin* for the week ending March 17, 1936, contains a chart showing the percentage of normal precipitation for the 18-month period, September 1934 to February 1936, inclusive, and also an article on the causes of duststorms. The migration of duststorm sources, as precipitation totals vary from normal, is of great interest.

Some of the Colorado duststorms of March are described by Choun [1] as the most severe and prolonged of record in that State. Visibility was often reduced to less than 10 feet, with consequent interference to traffic of all kinds; and sand, carried by winds of near-gale force, removed paint from automobiles, and pitted windshields, on the highway south of Pueblo.

[1] H. F. Choun, Climatological Data: Colorado Section, March 1936.

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SOLAR OBSERVATIONS

SOLAR RADIATION MEASUREMENTS DURING MARCH 1936

By IRVING F. HAND, *Assistant in Solar Radiation Investigations*

For a description of instruments employed and their exposures, the reader is referred to the January 1935 REVIEW, page 24.

Table 1 shows that solar radiation intensities averaged close to normal at all three Weather Bureau stations.

Table 2 shows a deficiency in the amount of total solar and sky radiation at all stations with the exception of Chicago, New York, Fresno, Twin Falls, and Riverside.

Polarization measurements made at Washington during March averaged 59.8 percent, with a maximum of 61 percent on the 20th. These are close to normal for the month. No observations were obtained at Madison because of snow and ice cover.

TABLE 1.—*Solar radiation intensities during March 1936*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	Sun's zenith distance: 8 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e
	mm	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm*
Mar. 6	5.16	------	0.63	0.82	1.08	------	------	------	------	------	2.62
Mar. 20	4.75	0.93	1.12	1.29	1.41	------	------	------	------	------	4.17
Mar. 30	6.50	------	------	.66	.86	------	------	------	------	------	6.50
Means	------	(.93)	(.88)	.92	1.12	------	------	------	------	------	------
Departures	------	+.20	+.07	−.03	−.03	------	------	------	------	------	------

MADISON, WIS.

Mar. 3	3.99	------	------	0.87	1.29	------	------	------	------	------	4.95
Mar. 4	2.87	------	------	1.28	1.40	1.59	------	------	------	------	1.96
Mar. 17	3.30	0.68	0.81	1.00	1.23	------	------	------	------	------	3.63
Mar. 18	2.87	.77	.95	1.09	1.30	1.54	------	------	------	------	3.63
Mar. 25	3.00	.82	.92	------	1.28	1.56	------	------	------	------	2.87
Mar. 27	3.45	------	------	------	------	1.48	------	------	------	------	3.00
Mar. 28	3.99	------	.86	------	------	------	------	------	------	------	6.27
Mar. 31	1.96	------	1.02	1.16	1.32	------	------	------	------	------	1.88
Means	------	.76	.91	1.08	1.30	1.54	------	------	------	------	------
Departures	------	−.16	−.11	−.08	−.01	−.04	------	------	------	------	------

TABLE 1.—*Solar radiation intensities during March 1936*—Contd.

LINCOLN, NEBR.

Date	Sun's zenith distance: 8 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e
	mm	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm*
Mar. 3	4.37	------	1.01	1.12	1.30	1.56	1.37	1.12	0.94	0.77	6.20
Mar. 4	2.37	------	------	------	1.46	1.66	------	------	------	------	2.16
Mar. 5	3.63	0.90	1.02	1.17	1.41	------	------	------	------	------	3.30
Mar. 7	3.81	.91	1.03	1.22	1.37	------	------	------	------	------	5.36
Mar. 9	4.17	------	------	------	------	------	1.08	.83	.60	.41	7.04
Mar. 12	3.00	------	1.22	1.32	1.51	1.63	1.43	1.31	1.16	------	2.62
Mar. 13	2.87	------	------	------	------	------	1.31	1.21	1.06	.95	3.30
Mar. 16	4.17	------	------	------	------	------	------	------	1.10	.93	3.00
Mar. 17	4.17	.87	.98	1.05	------	------	------	------	------	------	4.17
Mar. 18	3.45	------	------	------	------	------	1.19	.90	.70	.64	3.45
Mar. 19	4.57	------	------	------	------	------	1.44	1.25	1.09	1.00	2.26
Mar. 20	3.00	.78	.96	1.06	1.33	------	------	------	------	------	2.87
Mar. 21	3.30	.91	------	------	1.29	------	------	------	------	------	3.81
Mar. 24	3.30	.89	1.01	1.20	1.40	1.66	1.33	1.10	.94	.81	2.49
Mar. 25	2.62	------	------	------	------	------	.99	.69	.42	.28	2.74
Mar. 27	2.26	------	------	------	------	------	1.33	1.16	1.00	.88	2.74
Mar. 30	3.00	------	------	------	------	------	1.10	1.00	------	------	------
Means	------	.88	1.03	1.16	1.38	1.63	1.26	1.06	.91	.74	------
Departures	------	+.04	+.09	+.07	+.10	+.10	−.01	−.03	−.03	−.07	------

BLUE HILL, MASS.

1936											
Mar. 1	2.4	------	------	------	------	1.29	1.05	0.91	.79	0.67	2.5
Mar. 2	1.8	0.98	1.07	1.16	1.30	1.51	1.35	1.21	1.12	1.00	2.8
Mar. 4	4.0	.53	.68	.89	1.10	1.18	.97	.78	------	------	4.4
Mar. 6	2.9	.75	.86	.98	1.13	1.32	1.15	.88	.70	.55	2.4
Mar. 7	1.5	.82	.97	------	------	------	------	------	------	------	2.4
Mar. 8	1.5	.98	1.08	1.19	1.32	1.46	1.00	------	------	------	1.6
Mar. 10	6.8	------	------	------	------	1.18	------	------	------	------	6.8
Mar. 13	3.8	------	------	------	1.19	------	------	------	------	------	3.6
Mar. 14	3.0	------	------	------	------	1.14	.90	------	------	------	3.5
Mar. 15	4.6	------	------	------	.79	.94	.79	.65	------	------	5.4
Mar. 20	5.0	------	------	------	1.16	1.20	1.04	.95	.80	------	5.2
Mar. 23	2.8	------	1.06	1.17	1.28	1.42	.91	------	------	------	2.3
Mar. 24	2.9	------	------	------	1.30	------	------	------	------	------	4.0
Mar. 26	5.2	------	------	------	1.09	1.40	------	------	------	------	4.4
Mar. 28	5.4	------	------	------	1.30	1.51	------	------	------	------	3.0
Mar. 29	3.2	------	------	.94	1.10	1.27	------	------	------	------	4.6
Mar. 30	6.5	------	------	------	------	1.10	.85	------	------	------	7.6
Mar. 31	9.2	------	------	------	------	1.37	------	------	------	------	7.6
Means	------	.81	.95	1.06	1.17	1.29	1.00	.90	.85	.74	------

[1] Extrapolated.

TABLE 2.—*Average daily totals of solar radiation (direct + diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Pittsburgh	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	Friday Harbor	Ithaca
	Gram-calories per square centimeter															
1936	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Feb. 26	273	255	343	178	250	442	181	140	343	443	328	326	452	288	103	220
Mar. 4	308	325	343	281	257	468	278	123	413	299	320	311	398	335	219	233
Mar. 11	217	269	390	235	206	471	337	190	358	395	388	368	399	264	276	163
Mar. 18	235	316	396	280	288	469	294	184	434	443	522	424	391	286	296	280
Mar. 25	383	382	399	374	340	431	424	284	320	522	459	319	452	384	404	299
	Departures from weekly normals															
Feb. 26	−16	−25	+1	−31	+8	+47	------	−4	+37	------	−36	47	+74	------	−50	−4
Mar. 4	−10	+26	−15	+71	−6	+66	------	−30	+75	------	−56	25	−15	------	+18	+11
Mar. 11	−109	−44	+13	+19	−65	+58	------	−3	+9	------	−33	44	−26	------	+25	−85
Mar. 18	−98	−2	+1	+39	+2	+7	------	+12	+44	------	+45	61	−36	------	−18	−18
Mar. 25	+37	+32	−8	+134	+73	−51	------	+5	−21	------	−7	−14	+11	------	+16	−11
	Accumulated departures on—															
	+1,897	+1,001	−658	+1,799	+749	+1,267	------	+91	−196	------	−2,016	−2079	−1,078	------	+1,379	+203

TABLE 3.—*Total, I_m, and screened, I_y, I_r, solar-radiation-intensity measurements, obtained during March 1936, and determinations of the atmospheric-turbidity factor β, and water-vapor content; w=depth in millimeters, if precipitated*

AMERICAN UNIVERSITY, WASHINGTON, D. C.

Date and hour angle, 1936	Solar altitude	Air mass	I_m	I_y	I_r	$\beta_{I_{m\to}}$	$\beta_{I_{y\to}}$	β_{mean}	$\frac{I_{w=0}}{1.94}$	$\frac{I_{w=0}-I_m}{1.94}$	w	Air-mass type
									Percentage of solar constant			
Mar. 6	° ′	*m*	*gr. cal.*	*gr. cal.*	*gr. cal.*						mm	
0:52 a. m.	42 04	1.49	1.281	0.910	0.738	0.099	0.079	0.089	72.6	7.2	2.9	Pc.
0:48 a. m.	42 20	1.48	1.283	0.910	0.738	.099	.079	.089	72.6	7.1	2.9	

ATMOSPHERIC CONDITIONS DURING TURBIDITY MEASUREMENTS

Temperature, 7° C., wind, W. 8; visibility, 20 miles; blueness of sky, 4; polarisation, 58.9 percent.

BLUE HILL METEOROLOGICAL OBSERVATORY OF HARVARD UNIVERSITY

Mar. 1												
2.26 p. m.	29 57	2.00	1.067	0.740	0.633	0.117	0.107	0.112	62.5	8.0	5.4	Pc.
Mar. 2												
4:22 a. m.	12 39	4.50	1.022	.749	.645	.047	.094	.070	51.0	10.8	5.0	Pc.
2:55 a. m.	26 42	2.22	1.239	.853	.690	.045	.065	.055	72.0	9.2	6.0	
1:20 p. m.	37 12	1.65	1.407	.945	.770	.039	.074	.056	77.4	6.1	4.3	
Mar. 4												
3:12 a. m.	23 36	2.49	1.018	.737	.588	.062	.057	.060	68.1	16.5	10.3	Npf.
2:47 a. m.	28 38	2.08	1.091	.797	.648	.109	.081	.095	62.2	6.9	4.6	
0:08 a. m.	41 10	1.52	1.152	.778	.643	.109	.162	.136	65.3	6.8	5.3	
2:30 p. m.	30 26	1.97	.998	.720	.592	.129	.135	.132	60.1	9.5	6.6	
Mar. 6												
4:15 a. m.	14 56	3.84	.884	.640	.542	.066	.087	.076	53.0	8.1	4.1	Pc.
1:38 a. m.	37 03	1.65	1.171	.818	.657	.095	.093	.094	66.3	6.9	4.1	
1:13 p. m.	39 01	1.59	1.258	.845	.670	.036	.076	.056	77.0	13.1	10.1	
3:26 p. m.	22 56	2.56	.966	.663	.490	.035	.029	.032	73.8	24.7	15.4	
Mar. 7												
4:20 a. m.	14 22	3.97	.975	.703	.598	.055	.074	.064	56.8	6.3	3.0	Pc.
Mar. 8												
4:13 a. m.	15 02	3.82	1.096	.775	.656	.029	.062	.046	60.6	4.9	3.4	Pc.
2:16 a. m.	33 33	1.81	1.346	.909	.731	.035	.056	.046	76.3	7.9	5.6	
1:22 p. m.	38 54	1.59	1.302	.855	.685	.049	.053	.051	77.8	11.7	7.3	
3:10 p. m.	26 04	2.27	.865	.612	.501	.120	.145	.132	66.2	12.2	5.4	
Mar. 10												
0:32 a. m.	43 12	1.46	1.180	.775	.610	.086	.097	.092	73.0	12.9	8.6	Npc→Ta.
Mar. 13												
3:21 a. m.	25 55	2.28	1.152	.824	.660	.066	.054	.060	69.3	11.2	7.3	Pc.
2:14 a. m.	35 30	1.72	1.212	.892	.723	.138	.076	.107	68.0	6.3	5.0	
Mar. 14												
3:35 p. m.	23 58	1.78	.960	.692	.572	.175	.172	.174	62.7	13.8	7.0	Pc.
Mar. 15												
1:40 p. m.	40 12	1.55	.825	.596	.507	.148	.071	.110	63.0	20.9	13.6	Npc.
Mar. 20												
2:46 a. m.	33 25	1.81	1.169	.799	.659	.083	.078	.080	70.0	9.2	6.7	Npc.
0:00 noon	47 28	1.35	1.186	.797	.661	.110	.152	.131	73.5	12.7	9.4	
1:54 p. m.	46 53	1.37	1.089	.739	.607	.148	.194	.171	64.2	12.0	8.7	
4:17 p. m.	18 32	3.13	.926	.638	.550	.070	.118	.094	56.0	8.6	4.8	
Mar. 23												
3:30 a. m.	27 39	2.15	1.263	.854	.698	.057	.059	.058	69.7	5.1	3.3	Npc: Ta aloft.
3:45 p. m.	25 08	2.35	.870	.616	.528	.133	.192	.162	50.7	6.2	2.7	
Mar. 24												
0:27 a. m.	48 05	1.34	1.222	.800	.665	.075	.075	.075	76.6	14.0	10.4	Npc.
Mar. 26												
3:19 a. m.	30 08	1.99	1.090	.750	.639	.100	.168	.134	58.6	2.7	1.2	Npc.
2:29 a. m.	37 56	1.62	1.162	.782	.654	.101	.177	.139	63.6	4.0	2.3	
0:05 a. m.	49 50	1.30	1.294	.870	.722	.115	.164	.140	70.9	4.6	3.8	
Mar. 28												
3:14 a. m.	31 34	1.90	1.307	.807	.735	.055	.075	.065	73.0	6.0	3.1	Npc.
1:53 a. m.	43 19	1.46	1.349	.911	.728	.025	.063	.044	78.2	8.9	6.0	
0:24 a. m.	50 19	1.29	1.445	.948	.760	.034	.062	.048	80.6	6.5	4.9	
Mar. 29												
4:11 a. m.	21 58	2.65	.988	.701	.585	.079	.107	.093	60.1	9.3	5.7	Npc.
2:50 a. m.	35 41	1.71	1.147	.789	.643	.101	.121	.111	66.4	7.4	5.5	
0:01 a. m.	52 01	1.27	1.230	.809	.649	.061	.123	.092	75.6	12.4	10.1	
Mar. 30												
2:34 p. m.	37 45	1.63	.796	.592	.489	.200	.200	.200	55.8	14.9	9.1	Npc.
Mar. 31												
0:35 a. m.	51 00	1.28	1.119	.749	.594	.119	.125	.122	71.3	13.6	11.7	Npc→Ta.

Atmospheric conditions during solar radiation measurements, Blue Hill Observatory of Harvard University

Date and time from apparent noon	Air temperature	Wind, Beaufort scale	Visibility (scale 0-10)	Sky-blueness	Cloudiness and remarks
March 1936	°C.				
2; 2.51 a. m.	−5.6	NE 3	6	7	1 Stcu; dense haze.
2; 1.28 p. m.	−3.9	ENE 3	8	7	Few Ci; 2 Cu; light haze.
4; 2.56 a. m.	+3.6	SSW 2	7	7	1 Ci; mod. to dense haze.
4; 0.26 a. m.	+6.3	S 4	7	7	Few Ci; Few Acu; mod. to dense haze; Acu. near sun; wind blowing in tube.
6; 2.07 a. m.	−1.9	WNW 4	8	6	Zero clouds; mod. haze.
7; 3.23 a. m.	−7.2	N 3	7	7	5 Ci; Few Stcu; light to mod. haze; thin Ci near sun.
8; 2.25 a. m.	−3.1	NW 1	8	8	Few Ci; mod. to dense haze North.
10; 0.20 a. m.	+8.5	SE 1	6	5	1 Acu; mod. haze.
13; 3.03 a. m.	+3.1	SW 6	7	8	Few Frcu; light to mod. haze; gusty wind.
15; 0.19 a. m.	+7.9	ENE 1	6	4	Zero clouds; dense haze.
15; 1.14 p. m.	+9.4	NNE 2	7	4	Zero clouds; mod. haze.
20; 0.22 a. m.	+10.8	SSW 5	7	6	1 Ci; 1 Stcu; mod. to dense water haze.
23; 3.22 a. m.	+4.4	WNW 5	10	7	Few Ci.
24; 0.17 a. m.	+9.4	ENE 3	8	7	2 Ci; few Acu; light to mod. haze.
26; 2.48 a. m.	+6.9	NW 2	6	7	Few Ci; few Frcu; dense haze.
26; 0.02 a. m.	+11.1	W 2	7	8	Few Ci; mod. haze.
28; 2.16 a. m.	+9.3	WNW 5	8	8	Few Acu; few Frcu; light to mod. haze; wind gusty.
28; 0.24 a. m.	+10.9	WNW 5	8	8	Few Acu; few Cu; light haze; wind gusty.
29; 3.08 a. m.	+8.2	W 4	8	6	Zero clouds; light to mod. haze.
29; 0.20 a. m.	+13.2	WSW 5	8	7	Zero clouds; light to mod. haze.
30; 3.24 p. m.	+17.7	E 2	7	7	1 Ci; mod. to heavy haze.

PROVISIONAL SUNSPOT RELATIVE NUMBERS FOR MARCH 1936

[Dependent alone on observations at Zurich and its station at Arosa]

[Data furnished through the courtesy of Prof. W. Brunner, Eidgen. Sternwarte, Zurich, Switzerland]

March 1936	Relative numbers	March 1936	Relative numbers	March 1936	Relative numbers
1	*a* 74	11	79	21	104
2	68	12	*a* 67	22	96
3	*a* 60	13	*Ec* 59	23	82
4	*a* 55	14	68	24	53
5	*Mc* --	15	56	25	*Ec* 49
6	*a* 60	16	*a* 61	26	*ad* --
7	*Mc* 83	17	60	27	*d* --
8	89	18	*Mc* 66	28	*Mc* 98
9	*Ec* 88	19	*Macd* 87	29	98
10	*ad* 92	20	112	30	*Eac* 103
				31	109

Mean, 28 days = 77.7

a = Passage of an average-sized group through the central meridian.
b = Passage of a large group or spot through the central meridian.
c = New formation of a center of activity: E, on the eastern part of the sun's disk; W, on the western part; M, in the central circle zone.
d = Entrance of a large or average-sized center of activity on the east limb.

POSITIONS AND AREAS OF SUN SPOTS

NOTE.—The reports for March, not having been received, will be included with those for April in the next issue.

AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. LITTLE, in charge]

By L. T. SAMUELS

At those stations with a sufficient period of record for the determination of approximate normals, upper-air temperatures during March averaged above normal except on the Pacific Coast, where the departures were negative (see table 1). In practically all cases the departures were of moderate magnitude. Mean temperatures for the month were slightly lower over the central and north-central part of the country than over corresponding latitudes in the eastern and western sections.

Upper-air relative humidity departures were, in general, of opposite sign to those for temperature. Mean upper-air relative humidities for the month were strikingly low over Maxwell Field and Pensacola as compared to the other stations.

The directions of the upper-air wind resultants were close to normal in most cases (see table 2). Resultant velocities exceeded the normals over most of the northern stations, and were mostly below normal elsewhere. Departures were in general of small magnitude.

TABLE 1.—*Mean free-air temperatures and relative humidities obtained by airplanes during March 1936*

TEMPERATURE (° C.)

Stations	Altitude (meters) m. s. l.																Number of observations
	Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000		
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	
Barksdale Field (Shreveport), La.[1] (52 m)	12.8	------	15.4	------	13.6	------	11.0	------	8.2	------	5.5	------	2.8	------	−3.0	------	−10.0	------	30
Billings, Mont.[2] (1,088 m)	−0.9	------	------	------	------	------	−1.0	------	−3.8	------	−7.5	------	−11.1	------	−17.9	------	−24.5	------	31
Cheyenne, Wyo.[2] (1,873 m)	−2.4	------	------	------	------	------	------	------	−1.9	------	−2.4	------	−5.2	------	−12.1	------	−19.1	------	29
El Paso, Tex.[2] (1,194 m)	10.2	------	------	------	------	------	11.6	------	9.0	------	5.4	------	1.8	------	−5.3	------	−11.5	------	31
Fargo, N. Dak.[2] (274 m)	−6.1	------	−5.2	------	−5.4	------	−6.8	------	−8.7	------	−10.6	------	−13.1	------	−18.8	------	−25.9	------	29
Kelly Field (San Antonio), Tex.[1] (206 m)	12.3	------	16.2	------	14.8	------	13.1	------	10.9	------	8.1	------	4.9	------	−1.9	------	−9.3	------	30
Lakehurst, N. J.[3] (39 m)	4.8	------	6.0	------	4.2	------	2.3	------	0.1	------	−2.4	------	−5.0	------	−11.6	------	−21.3	------	26
Maxwell Field (Montgomery), Ala.[1] (52 m)	10.7	------	13.1	------	10.6	------	7.0	------	5.0	------	2.8	------	+0.3	------	−5.5	------	−13.0	------	24
Mitchel Field (Hempstead, Long Island), N. Y.[1] (29 m)	4.4	------	5.4	------	3.6	------	1.5	------	−0.3	------	−2.8	------	−5.6	------	−12.6	------	------	------	21
Murfreesboro, Tenn.[2] (174 m)	7.5	------	10.2	------	8.5	------	6.0	------	3.3	------	0.6	------	−2.2	------	−8.4	------	−14.9	------	31
Norfolk, Va.[2] (10 m)	9.9	+2.6	12.1	+5.2	9.6	+4.7	6.4	+3.8	3.9	+3.5	1.2	+2.9	−1.6	+2.4	−8.1	+1.8	−14.0	+1.8	17
Oklahoma City, Okla.[2] (391 m)	10.3	------	11.6	------	11.7	------	9.7	------	6.9	------	4.1	------	1.0	------	−5.9	------	−12.9	------	26
Omaha, Nebr.[2] (300 m)	1.7	+1.9	2.8	+2.3	3.3	+2.3	2.3	+2.0	0.3	+1.5	−2.3	+1.3	−5.5	+1.0	−12.3	+0.7	−19.2	+0.6	31
Pearl Harbor, Territory of Hawaii[3] (6 m)	20.2	−2.3	18.9	−1.0	15.3	−0.9	12.2	−1.2	10.4	−0.7	9.2	−0.2	6.1	−1.1	−0.5	−2.3	------	------	31
Pensacola, Fla.[3] (2 m)	14.0	+1.7	14.5	+2.7	12.5	+2.5	10.6	+2.5	8.2	+2.1	5.6	+1.6	3.3	+1.5	−2.6	+1.4	−9.4	+1.2	28
San Diego, Calif.[3] (10 m)	12.3	−1.7	12.2	−0.7	11.9	−0.3	10.3	+0.1	7.6	−0.3	4.5	−0.7	1.3	−1.0	−4.2	−0.2	−10.1	+0.5	30
Scott Field (Belleville), Ill.[1] (135 m)	4.3	------	6.5	------	6.2	------	4.7	------	2.3	------	−0.4	------	−3.3	------	−9.1	------	−15.1	------	31
Seattle, Wash.[3] (10 m)	6.4	−2.4	2.5	−3.3	−0.5	−3.3	−2.8	−2.8	−6.4	−3.4	−10.0	−4.1	−13.3	−4.6	−18.0	−3.6	−25.0	−3.8	8
Spokane, Wash.[3] (596 m)	0.8	------	------	------	2.2	------	0.4	------	−2.7	------	−5.9	------	−9.4	------	−16.5	------	−23.7	------	31
Washington, D. C.[3] (13 m)	6.2	+0.8	8.1	+3.8	6.1	+3.7	3.7	+3.4	1.3	+3.1	−1.1	+2.8	−4.2	+1.9	−10.0	+1.8	−15.8	+2.0	23
Wright Field (Dayton), Ohio[1] (244 m)	3.4	------	4.4	------	4.2	------	2.6	------	0.5	------	−1.8	------	−4.1	------	−10.0	------	−17.1	------	30

[1] Army. [2] Weather Bureau. [3] Navy.

TABLE 1.—*Mean free-air temperatures and relative humidities obtained by airplanes during March 1936*—Continued

RELATIVE HUMIDITY (PERCENT)

Stations	Altitude (meters) m. s. l.																		Number of observations
	Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000		
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	
Barksdale Field (Shreveport), La.	73	-------	60	-------	54	-------	50	-------	45	-------	38	-------	39	-------	37	-------	35	-------	-------
Billings, Mont.	60	-------	-------	-------	-------	-------	53	-------	52	-------	56	-------	60	-------	61	-------	58	-------	-------
Cheyenne, Wyo.	64	-------	-------	-------	-------	-------	-------	-------	62	-------	56	-------	56	-------	57	-------	52	-------	-------
El Paso, Tex.	35	-------	-------	-------	-------	-------	34	-------	35	-------	38	-------	39	-------	39	-------	32	-------	-------
Fargo, N. Dak.	87	-------	79	-------	68	-------	63	-------	61	-------	60	-------	57	-------	51	-------	52	-------	-------
Kelly Field (San Antonio), Tex.	83	-------	71	-------	65	-------	57	-------	55	-------	52	-------	51	-------	49	-------	46	-------	-------
Lakehurst, N. J.	78	-------	62	-------	61	-------	58	-------	50	-------	49	-------	49	-------	46	-------	42	-------	-------
Maxwell Field (Montgomery), Ala.	72	-------	51	-------	44	-------	46	-------	33	-------	23	-------	20	-------	19	-------	22	-------	-------
Mitchel Field (Hempstead, Long Island), N. Y.	83	-------	69	-------	67	-------	62	-------	56	-------	54	-------	56	-------	52	-------	-------	-------	-------
Murfreesboro, Tenn.	81	-------	67	-------	66	-------	62	-------	59	-------	55	-------	55	-------	51	-------	48	-------	-------
Norfolk, Va.	75	+7	58	−3	52	−6	55	−2	51	−3	46	−4	45	−1	50	+8	54	+10	-------
Oklahoma City, Okla.	53	-------	52	-------	47	-------	44	-------	43	-------	41	-------	41	-------	42	-------	40	-------	-------
Omaha, Nebr.	73	−4	67	−5	56	−5	50	−4	46	−5	45	−6	45	−7	47	−6	46	−7	-------
Pearl Harbor, Territory of Hawaii	81	+9	79	+4	83	+5	80	+6	71	+5	50	−9	42	0	35	+5	-------	-------	-------
Pensacola, Fla.	85	+7	72	+4	61	0	48	−8	41	−11	30	−12	31	−13	26	−13	28	−11	-------
San Diego, Calif.	85	+11	78	+8	60	+4	45	−1	40	+2	35	+2	33	+3	28	+2	26	0	-------
Scott Field (Belleville), Ill.	77	-------	62	-------	54	-------	47	-------	45	-------	42	-------	43	-------	39	-------	41	-------	-------
Seattle, Wash.	73	+3	80	+9	80	+11	72	+6	71	+7	66	+7	62	+8	57	+7	56	+7	-------
Spokane, Wash.	78	-------	-------	-------	66	-------	61	-------	61	-------	57	-------	59	-------	60	-------	58	-------	-------
Washington, D. C.	77	+9	59	−4	56	−5	58	−2	56	−2	47	−6	51	+1	52	+4	49	+4	-------
Wright Field (Dayton), Ohio	80	-------	75	-------	67	-------	59	-------	61	-------	61	-------	58	-------	57	-------	59	-------	-------

Observations taken about 4 a. m., 75th meridian time, except along the Pacific coast and Hawaii where they are taken at dawn.

NOTE.—The departures are based on "normals" covering the following total number of observations made during the same month in previous years, including the current month: Norfolk, 146; Omaha, 154; Pearl Harbor, 132; Pensacola, 153; San Diego, 182; Seattle, 60; Washington, 210.

Errata: "Monthly Weather Review", December 1935—Murfreesboro, Tenn., mean annual temperature for 1935 at 5-kilometer level should be changed from −8.9° C., to −10.0° C.

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot-balloon observations made near 5 a. m. (E. S. T.) during March 1936*

[Wind from N=360°, E=90°, etc.]

Altitude (m) m. s. l.	Albuquerque, N. Mex. (1,554 m)		Atlanta, Ga. (309 m)		Billings, Mont. (1,068 m)		Boston, Mass. (15 m)		Cheyenne, Wyo. (1,873 m)		Chicago, Ill. (192 m)		Cincinnati, Ohio (153 m)		Detroit, Mich. (204 m)		Fargo, N. Dak. (274 m)		Houston, Tex. (21 m)		Key West, Fla. (11 m)		Medford, Oreg. (410 m)		Murfreesboro, Tenn. (180 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	276	1.4	276	0.9	292	3.6	201	0.7	275	3.6	290	1.4	244	0.8	300	0.5	209	2.0	207	0.2	90	1.2	324	0.7	209	1.5
500	-------	-------	253	2.7	-------	-------	268	4.5	-------	-------	247	3.4	238	5.6	265	1.5	293	4.5	179	2.7	127	2.6	312	1.0	223	5.4
1,000	-------	-------	274	6.4	-------	-------	276	7.3	-------	-------	271	6.8	269	9.5	276	6.0	298	7.2	231	0.8	195	1.6	302	1.7	266	7.6
1,500	-------	-------	284	7.4	277	10.4	272	9.7	-------	-------	269	8.1	285	10.0	276	7.8	294	9.0	301	3.1	233	1.6	274	2.0	278	9.5
2,000	300	5.5	281	7.7	287	10.4	288	10.3	279	7.0	275	9.4	281	10.7	278	9.9	302	10.8	302	4.1	265	3.6	289	3.3	278	9.7
2,500	302	7.4	275	7.0	294	11.9	287	10.3	286	12.2	286	12.1	287	11.6	285	9.2	300	13.2	302	4.8	270	4.6	299	6.4	294	11.8
3,000	293	8.1	275	9.4	293	13.9	-------	-------	295	13.1	280	14.0	-------	-------	297	10.8	306	13.1	302	6.9	277	6.4	293	7.8	-------	-------
4,000	290	10.0	278	12.9	295	13.8	-------	-------	293	9.0	274	14.7	-------	-------	-------	-------	-------	-------	291	5.1	272	9.2	297	10.5	-------	-------
5,000	286	11.2	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	282	10.4	-------	-------

Altitude (m) m. s. l.	Newark, N. J. (14 m)		Oakland, Calif. (8 m)		Oklahoma City, Okla. (402 m)		Omaha, Nebr. (306 m)		Pensacola, Fla.[1] (24 m)		St. Louis, Mo. (170 m)		Salt Lake City, Utah (1,294 m)		San Diego, Calif. (15 m)		Sault Ste. Marie, Mich. (198 m)		Seattle, Wash. (14 m)		Spokane, Wash. (603 m)		Washington, D. C. (10 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	280	1.6	344	0.9	184	0.9	312	1.2	11	1.1	274	1.8	151	2.3	289	0.7	271	1.0	165	1.9	206	1.1	326	0.9
500	264	6.3	345	3.7	206	1.5	305	2.2	309	2.7	268	5.8	-------	-------	282	2.5	272	1.3	208	3.8	-------	-------	282	4.6
1,000	273	8.8	11	5.4	244	4.7	290	5.9	318	5.9	273	10.3	-------	-------	309	3.2	292	5.2	228	4.3	225	5.1	283	6.1
1,500	278	11.4	359	4.7	263	7.5	289	9.1	322	6.0	290	11.6	164	2.2	315	3.8	290	6.9	246	5.5	244	6.9	285	8.2
2,000	272	9.4	352	3.7	271	7.8	290	11.3	314	8.0	290	11.6	245	2.0	319	3.7	294	8.4	255	4.6	249	6.5	275	7.7
2,500	-------	-------	358	3.4	279	8.6	299	13.2	306	5.7	297	11.7	291	4.0	314	3.3	292	8.9	283	4.3	260	8.5	252	7.9
3,000	-------	-------	353	3.4	294	7.1	296	13.6	311	7.0	288	13.9	297	7.2	357	3.0	306	8.2	282	6.5	274	7.5	256	10.3
4,000	-------	-------	-------	-------	-------	-------	-------	-------	311	5.2	-------	-------	301	9.3	336	7.9	-------	-------	272	9.2	287	10.9	-------	-------
5,000	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	295	9.3	355	6.6	-------	-------	-------	-------	-------	-------	-------	-------

[1] Navy stations.

RIVERS AND FLOODS

[River and Flood Division, MONTROSE W. HAYES, in charge]

By W. J. MOXOM

Unprecedented floods occurred during March 1936 in many of the rivers of the Atlantic seaboard, from Virginia northward into New England. Complete reports of estimated flood losses are not yet available, but it is safe to assume they were the largest of record. At the close of the month the Ohio River flood-crest had not reached the Mississippi River at Cairo, Ill.

A full report on the March 1936 floods will be made in a later number, or perhaps a Supplement, of the REVIEW.

WEATHER ON THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, I. R. TANNEHILL in charge]

NORTH ATLANTIC OCEAN, MARCH 1936

By H. C. HUNTER

Atmospheric pressure.—Barometric readings averaged below normal over the greater part of the North Atlantic area. At Horta, March was the third successive month with pressure averaging more than 0.20 inch lower than normal; but at Horta constantly, and at Bermuda usually, the pressure was higher than normal during March 1 to 11.

Reykjavik pressure averaged higher than normal for the fourth successive month, but the March departure was small. Most northern regions showed March pressure above normal, with the greatest excess, 0.24 inch, at Belle Isle, Newfoundland, where the pressure was very seldom below normal save at times after the 22d.

Vessel pressure extremes, as far as yet reported, were 30.72 and 28.88 inches. The former was noted during the forenoon of the 10th, about 400 miles south-southeast of Cape Race, Newfoundland, on the American steamship *Argosy;* while the low mark was recorded on the American steamship *Yaka*, 500 miles west-southwest of Valencia, Ireland, the forenoon of the 24th. Table 1 indicates that the shore station at Reykjavik, Iceland, noted pressure of 28.87 inches on the 4th.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, March 1936*

Station	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.89	-------	30.28	22	29.43	15
Reykjavik, Iceland	29.71	+0.03	30.22	8	28.87	4
Lerwick, Shetland Islands	29.82	+.12	30.19	14	29.30	31
Valencia, Ireland	29.72	−.18	30.32	16	29.10	22
Lisbon, Portugal	29.88	−.12	30.30	6	29.42	11
Madeira	29.98	−.03	30.33	6	29.73	24
Horta, Azores	29.94	−.24	30.49	4	29.33	16
Belle Isle, Newfoundland	30.04	+.24	30.46	10	29.28	29
Halifax, Nova Scotia	30.03	+.07	30.50	9, 11	29.34	22
Nantucket	29.92	−.06	30.40	8	29.13	21
Hatteras	29.92	−.12	30.33	8	29.23	17
Bermuda	30.05	−.09	30.36	9	29.68	1
Turks Island	29.99	−.03	30.12	23	29.85	17
Key West	29.98	−.06	30.14	22	29.70	9
New Orleans	29.97	−.07	30.27	1	29.71	16

NOTE.—All data based on a.m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

Cyclones and gales.—March failed to equal the records of the winter months just preceding it for storminess over the North Atlantic, since force 11 was noted only three times, and force 12 not at all. The period of greatest storm activity lasted from the 10th to 22d.

A well-marked LOW was central not far east of Jacksonville, Fla., on the morning of the 10th, and moved northeastward, passing Hatteras on the 11th. Thence for 2 days it moved more to northward, since high pressure near Newfoundland blocked its further eastward movement. Numerous ships met gales near the eastern coast of the United States on the 10th to 12th. On the 14th, southeast of Sable Island, the British motorship *Cingalese Prince* noted force 11, with moderately high barometer, the vessel being in a district with steep pressure gradient between the HIGH to eastward and the LOW to westward. Charts IX and X indicate the situations on the 10th and 11th, respectively.

On the 16th a low-pressure area covered the western part of the Gulf of Mexico and land districts to northward, with the result that many vessels noted gales over Gulf waters. A strong norther was felt at Alvaro Obregon, Mexico, while a moderate southeasterly gale was noted near Jamaica. On the 17th, the LOW center was over Virginia; and on the 19th, over New York. On the 17th and 18th many vessels met gales in waters from Florida to the Chesapeake capes. On the 19th the British motorship *Victolite*, midway between Bermuda and southern Nova Scotia, noted force 11. Chart XI shows the conditions of the 18th.

The low-pressure area was reinforced from the west on the 20th; and on the 21st a large system of low pressure extended from Hudson Strait to Virginia, and many gales were reported off the United States coast between latitudes 30° and 42°. The final instance of force 11 was noted southeast of New Jersey on the American steamship *Standard*. This situation on the 21st is indicated on chart XII.

A LOW, usually of large area, moving irregularly and generally but slowly, dominated the waters between the Azores, the British Isles, and the Iberian peninsula from the 13th to the 26th. A moderate number of gales in connection with this storm were noted, particularly about the 20th and the 24th, but no force greater than 10, which was met by 6 vessels, was connected with this cyclone.

Fog.—In most portions of the North Atlantic area where fog is likely to occur, it was considerably more frequent during March than it had been during the preceding February. The chief exception was over the portion of the route to northern Europe lying between the 40th meridian and the shores of Ireland, where March 1936, is indicated as almost entirely free from fog.

The greatest frequency was in the 5° square from 40° to 45° N., 50° to 55° W., where fog was encountered on 19 days, including almost every day from the 11th to 25th, inclusive. In general there were many more days of fog than usual in the Grand Banks region and thence westward and southwestward to the vicinity of Hatteras.

Near the western coast of Europe, from the Strait of Gibraltar to waters around southern England, fog was met to some extent during the last 5 days of March.

The Gulf of Mexico to northward of the 25th parallel had some fog, mainly about the middle of the month and during the last few days.

A few collisions due to fog have been reported in scattered places, but none seems to have been especially disastrous. During the 9th and 10th fog was notably dense and persistent over New York harbor, with serious consequent delay to movements of vessels.

Ice.—In coastal waters of the northeastern United States hardly any ice remained when March began; but river ice at times hampered movements of vessels in New York and other harbors. The winter ice damage to lights, buoys, and similar aids to navigation was great beyond precedent in the North Atlantic district, according to reports from the Lighthouse Service.

OCEAN GALES AND STORMS, MARCH 1936

Vessel	Voyage		Position at time of lowest barometer		Gale began March	Time of lowest barometer March	Gale ended March	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′				*Inches*					
Exermont, Am. S. S.	Casablanca	New York	35 43 N.	65 12 W.	1	4a, 1	1	29.63	NNW.	N, 8	N.	N, 9	NNW-N.
Circe Shell, Br. M. S.	Rotterdam	Curacao	46 30 N.	11 40 W.	1	2p, 1	2	29.35	NE.	NE, 8	N.	NNW, 10	NE-NNW.
Bloemfontein, Du. M. S.	Tenerife	Southampton	43 30 N.	9 20 W.	1	5p, 1	2	29.08	W	SW, 5	N.	NE, 9	SW-ENE.
Stuyvesant, Du. S. S.	Madeira	Plymouth	41 15 N.	11 31 W.	1	9p, 1	3	29.19	WNW.	NNW, 9	N.	N, 10	NW-NNW-N.
Bennekom, Du. S.S.	LasPalmas	Dunkirk	34 50 N.	14 37 W	2	11a, 2	2	29.81	NNW.	NNW, 8	NNW.	NNW, 8	
Black Tern, Am. S. S.	Antwerp	New York	48 05 N.	33 00 W.	5	8p, 5	6	29.82	WSW.	WSW, 8	N.	WNW, 10	WSW-WNW.
American Trader, Am. S. S.	London	do	50 00 N.	11 00 W.	8	Noon, 8	8	29.60	NNE.	NE, 6	N.	NNE, 9	NE-NNE.
Texan, Am. S. S.	Cristobal	Norfolk	30 40 N.	74 58 W.	8	4p, 10	10	29.69	NE.	SE, 8	S.	SE, 10	None.
Dilworth, Am. S. S.	Baltimore	Colon	32 28 N.	75 03 W.	9	4a, 11	11	29.62	SSE.	SSW, 5	SW.	SE, 9	SSE-SSW.
Betterton, Am. S.S.	Houston	Baltimore	35 00 N.	75 10 W.	12	Noon, 12	12	29.40	SW.	SW, 8	WNW.	WSW, 9	SW-W.
W. S. Farish, Am. S. S.	New Orleans	New York	[1]26 00 N.	85 09 W.	14	10a, 14	14	29.93	N.	SSE, 6	NNE.	N, 9	S-SE-N.
Cingalese Prince, Br. M. S.	Dakar	Halifax	41 10 N.	56 20 W.	14	Noon, 14	14	30.14	SW.	SW, 11	SW.	SW, 11	None.
Heddernheim, Ger. S. S.	Tampa	Rotterdam	46 00 N.	31 55 W.	13	4a, 16	16	29.99	N.	ENE, 6	NE.	NNE, 9	NE-ENE.
St. Mary, Br. S. S.	Frontera	New Orleans	24 40 N.	90 50 W.	16	4p, 16	17	29.50	N.	N, 1	N.	N, 8	
Gulftrade, Am. S. S.	Beverly	Port Arthur	27 36 N.	88 50 W.	16	1a, 17	17	29.79	NW.	NW, 8	N.	NW, 8	S-NW-NNW.
Santa Lucia, Am. S. S.	New York	Cristobal	17 36 N.	75 12 W.	16	7a, 17	17	29.89	E.	ESE, 7	SE.	ESE, 7	ESE-SE.
Yankee Arrow, Am. S. S.	Providence	Beaumont	25 56 N.	85 52 W.	17	do	18	29.84	NNW.	NW, 8	NNW.	NNW, 8	NW-NNW.
W. S. Farish, Am. S. S.	New Orleans	New York	33 20 N.	76 30 W.	17	1p, 17	17	29.29	SE.	S, 10	SW.	S, 10	S-WSW.
Volendam, Du. S. S.	Nassau	do	36 16 N.	74 14 W.	16	4p, 17	17	29.37	SSE.	SSE, 9	SW.	SSE, 10	None.
Steel Trader, Am. S. S.	New York	Cristobal	34 18 N.	75 00 W.	17	do	18	29.36	SE.	SE, 8	WSW.	SSE, 10	SE-SW.
Andrea F. Luckenbach, Am. S. S.	Cristobal	New York	34 15 N.	74 14 W.	17	6a, 18	18	29.45	SSE.	SW, 10	W.	SW, 10	WSW-SW-W.
San Alvaro, Br. M. S.	Puerto Mexico	do	32 10 N.	77 35 W.	17	Noon, 18	18	29.53	W.	NW, 7	W.	WNW, 9	NW-WNW.
Victolite, Br. M. S.	Halifax	Cartagena	36 44 N.	64 55 W.	18	3a, 19	19	29.78	SE.	SE, 10	S.	SE, 11	SE-SSE.
Independence Hall, Am. S. S.	Bordeaux	New York	45 26 N.	31 54 W.	19	8p, 19	21	29.49	W.	W, 8	NNW.	NNW, 10	W-NNW.
Duquesne, Am. S. S.	Antwerp	Galveston	40 36 N.	24 18 W.	20	8a, 20	21	29.43	NW.	WNW, 7	WNW.	WNW, 9	None.
Cadillac, Br. S. S.	Aruba	London	42 00 N.	27 25 W.	20	10a, 20	21	29.43	NW.	WNW, 8	WNW.	WNW, 9	
Salinas, U. S. N.	Norfolk	Houston	32 18 N.	75 45 W.	20	4a, 21	22	29.49	S.	W, 8	NNW.	W, 10	WSW-W.
Laurits Swenson, Nor. M. S.	Feroya	Colon	48 50 N.	20 39 W.	21	do	23	29.21	NW.	NW, 5	WNW.	NNW, 10	NE-NW-NNW.
Gulfhawk, Am. M. S.	Philadelphia	Las Piedras	30 16 N.	73 50 W.	20	71, 21	21	29.42	SSW.	WSW, 9	WNW.	WSW, 10	SSW-WSW.
Executive, Am. S. S.	Lisbon	New York	38 46 N.	15 58 W.	20	11a, 21	23	29.49	SW.	SW, 8	NW.	SW, 10	
Amazone, Du. S. S.	New York	Curacao	38 09 N.	73 27 W.	21	do	22	29.14	W.	SSW, 6	NW.	NW, 10	S-W.
Coamo, Am. S. S.	San Juan	New York	30 30 N.	70 20 W.	21	3p, 21	22	29.68	W.	W, 8	NW.	WNW, 10	
Standard, Am. S. S.	New York	Aruba	38 05 N.	73 16 W.	21	do	22	29.12	W.	WSW, 6	WNW.	NW, 11	SW-W.
Volendam, Du. S. S.	do	Bermuda	40 06 N.	72 28 W.	21	4p, 21	23	29.03	SSW.	SSW, 4	WNW.	WNW, 9	SSW-W.
Queen of Bermuda, Br. S. S.	Bermuda	New York	[1]35 10 N.	67 38 W.	21	6a, 22	22	29.62	SW.	W, 8	NW.	NW, 9	SW-WNW.
Sundance, Am. S. S.	Charleston	Liverpool	46 55 N.	22 40 W.	22	10a, 24	24	29.00	NW.	NW, 8	NW.	NNW, 10	NW-NNW.
Bernice, Du. S. S.	Puerto Barrios	Amsterdam	47 37 N.	19 00 W.	22	11a, 24	24	28.96	NNW.	NNW, 3	NNW.	NNW, 9	NNW-S.
Yselhaven, Du. S. S.	New Orleans	Bremen	46 30 N.	24 51 W.	21	4a, 25	25	29.40	WSW.	NW, 6	N.	N, 10	NW-N.
Amapala, Hond. S. S.	New York	Vera Cruz	21 40 N.	90 50 W.	25	3a, 26	26	29.73	SE.	SE, 6	SE.	SE, 6	None.
Laurits Swenson, Nor. M. S.	Feroya	Colon	28 20 N.	47 02 W.	28	3a, 28	28	29.72	WNW.	W, 5	WNW.	WNW, 8	Do.
Executive, Am. S. S.	Lisbon	New York	37 52 N.	50 37 W.	30	9a, 30	30	29.55	WSW.	W, 10	NW.	W, 10	
Cavina, Br. S. S.	Avonmouth	Kingston	37 33 N.	30 14 W.	31	2p, 31	[2]2	29.66	SW.	SW, 5	WNW.	NW, 8	SW-WSW.
Antinous, Am. S. S.	Antwerp	Tampa	40 00 N.	35 30 W.	31	11p, 31	([3])2	29.22	WSW.	WSW, 8	NNW.	NW, 9	WSW-NW.
NORTH PACIFIC OCEAN													
Empress of Asia, Br. S. S.	Victoria, B. C.	Yokohama	46 52 N.	160 27 E.	1	Noon, 1	2	29.03	ENE.	N, 8	NW.	N, 8	
Nako Maru, Jap. M. S.	Los Angeles	do	[1]46 58 N.	171 12 E.	2	Noon, 2	3	28.76	SW.	SW, 9	WNW.	SW, 9	SSW-WNW.
Pres. Adams, Am. S. S.	Honolulu	Kobe	33 21 N.	158 03 E.	2	do	3	29.78	W.	W, 2	W.	W, 9	ESE-W.
Hikawa Maru, Jap. M. S.	Vancouver, B. C.	Yokohama	51 55 N.	150 28 W.	3	10p, 3	3	29.24	SSW.	WNW, 4	S.	S, 8	S-WNW-NNW.
Pennsylvania, Am. S. S.	Manila	San Francisco	42 14 N.	163 24 W.	5	10a, 5	5	29.44	S.	SSW, 10	W.	SSW, 10	SSW-WSW.
Golden Mountain, Am. S. S.	Tandoc, P. I.	do	42 32 N.	166 30 W.	4	6p, 5	5	29.25	WSW.	SSW, 9	WSW.	SW, 10	WSW-W.
Kaiwo Maru, Jap. Bark	Saipan	Yokohama	30 05 N.	138 04 E.	9	9p, 8	9	[1]29.68	W.	NW, 6	NW.	WNW, 8	NW-W.
Tyndareus, Br. S. S.	Yokohama	Victoria, B. C.	45 17 N.	163 08 E.	9	10a, 10	11	28.79	SE.	SSE, 7	WSW.	S, 9	SE-S.
Hikawa Maru, Jap. M. S.	Vancouver, B. C.	Yokohama	45 50 N.	156 53 E.	10	Noon, 10	11	28.39	WNW.	SW, 3	NW.	NW, 10	SW-NW.
Empress of Russia, Br. S. S.	Yokohama	Vancouver, B. C.	50 53 N.	155 18 W.	10	8a, 11	13	29.66	S.	SSW, 9	W.	SSW, 9	S-SW.
Empress of Canada, Br. S. S.	Honolulu	Yokohama	25 15 N.	167 16 W.	14	3p, 14	15	30.01	NW.	NW, 6	ENE.	NE, 8	SE-NW-N.
Birchbank, Br. M. S.	Los Angeles	Taketoyo	[1]33 13 N.	139 00 E.	13	4p, 14	14	29.57	S.	W, 8	WNW.	SW, 9	SW-WNW.
Heian Maru, Jap. M. S.	Yokohama	Vancouver, B. C.	43 21 N.	156 50 E.	13	8a, 15	15	29.62	S.	SSW, 9	SSW.	SSW, 9	
Pres. McKinley, Am. S. S.	Victoria, B. C.	Yokohama	50 00 N.	131 18 W.	15	1a, 16	16	29.67	SSE.	WSW, 9	WSW.	WSW, 9	S-WSW.
Talthybius, Br. S. S.	Vancouver, B. C.	do	47 48 N.	175 07 E.	19	10p, 19	20	29.69	SSW.	SW, 9	W.	SSW, 10	SSW-WSW.
Hanover, Am. S. S.	Bulan	San Francisco	34 35 N.	163 45 W.	18	10p, 21	21	29.60	NW.	ENE, 8	ENE.	NNE, 11	NNE-ESE.
Pres. McKinley, Am. S. S.	Victoria, B. C.	Yokohama	52 08 N.	162 00 W.	19	2a, 20	20	30.08	SW.	SW, 9	SW.	SW, 10	SSW-SW.
Empress of Japan, Br. S. S.	Honolulu	Victoria, B. C.	28 58 N.	151 00 W.	21	1a, 21	21	29.86	ESE.	SE, 10	SE.	SE, 10	NE-SE.
Malolo, Am. S. S.	San Francisco	Honolulu	37 46 N.	122 46 W.	21	6p, 21	22	29.67	WNW.	WNW, 8	N.	NW, 10	None.
Ary Lensen, Br. M. S.	Vancouver, B. C.	Balboa	38 55 N.	124 21 W.	20	8p, 21	23	29.94	NW.	NNW, 11	NW.	NNW, 11	NNW-WNW.

[1] Position approximate. [2] April. [3] Barometer uncorrected.

Vessel	Voyage		Position at time of lowest barometer		Gale began March	Time of lowest barometer March	Gale ended March	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
								Inches					
Pres. Jefferson, Am. S. S.	Yokohama	Victoria, B. C.	36 41 N.	143 50 E.	22	2p, 22	23	29.86	N	N, 10	NE	NNW, 10	NNW-NNE.
Mana, Am. S. S.	Port Angeles	Honolulu	[1]46 36 N.	128 59 W.	23	11a, 23	25	29.93	NW	NW, 5	NW	NNW, 9.	None.
Empress of Japan, Br. S. S.	Honolulu	Victoria, B. C.	46 22 N.	128 30 W.	23	2a, 24	24	29.74	NNW	NW, 8	NW	NW, 9	
Pres. McKinley, Am. S. S.	Victoria, B. C.	Yokohama	48 33 N.	168 06 E.	23	6a, 24	24	29.71	NNE	NNE, 10	NNE	NNE, 11	None.
San Diego Maru, Jap. M. S.	Yokohama	San Francisco	43 30 N.	163 20 E.	23	do	24	29.22	NE	N, 9	N	N, 9	
Golden Star, Am. S. S.	San Francisco	Yokohama	32 23 N.	151 15 E.	26	6a, 26	27	29.43	S	SW, 10	NW	WNW, 11	S-WNW.
Fujisan Maru, Jap. M. S.	Yokohama	San Francisco	37 22 N.	157 15 E.	26	2p, 26	26	29.21	SSE	S, 10	SW	S, 10	SSE-S-SW.
Kentucky, Am. S. S.	Otaru	do	42 00 N.	154 00 E.	25	do	26	29.00	SE	SE, 10	W	SE, 10	SE-WSW.
Pres. McKinley, Am. S. S.	Victoria, B. C.	Yokohama	41 32 N.	146 50 E.	26	4p, 26	27	29.06	NW	NW, 8	NW	NW, 10	None.
Golden Dragon, Am. S. S.	Manila	San Francisco	37 19 N.	159 21 E.	26	5p, 26	26	29.23	S	SSE, 10	W	SSE, 10	SSE-W.
Bintang, Du. M. S.	Dahikan	Los Angeles	32 54 N.	160 43 E.	26	8p, 26	27	29.46	S	S, 9	W	S, 9	S-WSW.
Do	do	do	35 22 N.	167 51 E.	28	4a, 28	30	29.42	W	W, 7	W	W, 10	None.
Nojima Maru, Jap. M. S.	Yokohama	do	46 12 N.	173 54 W.	30	Mdt, 27	30	29.45	SE	SE, 6	ESE	ESE, 8	SE-ESE.
Pres. Pierce, Am. S. S.	Honolulu	San Francisco	35 40 N.	129 50 W.	30	2p, 30	31	29.67	N	N, 8	NNW	N, 8	NW-N-NNW.
Goolistan, Br. S. S.	Vancouver	Balboa	34 07 N.	121 00 W.	30	8a, 30	31	29.52	ESE	S, 7	WNW	WNW, 8	SW-SE.

[1] Barometer uncorrected.

NORTH PACIFIC OCEAN, MARCH 1936

By WILLIS E. HURD

Atmospheric pressure.—The pressure distribution over the North Pacific Ocean during March 1936 was very different from that prevailing during the previous month. In February the Aleutian and connected cyclones covered the greater part of the ocean north of the Tropics. In March the northern LOWS extended southward little beyond middle latitudes. While in February, on the average, there was no midocean anticyclone, in March a broad belt of high pressure extended across the Pacific between 20° and 40° north latitude. At Midway Island, which is usually in the anticyclonic belt, conditions during the 2 months were in strong contrast. In February the average pressure of 29.86 was 0.13 inch below normal; in March, the average of 30.21 was 0.14 inch above.

The center of the Aleutian LOW in March lay to west and southwest of the Alaska Peninsula. In Far Eastern waters the influence of the Asiatic continental anticyclone extended eastward across Chinese and Japanese waters.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, March 1936, at selected stations*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Point Barrow	29.99	−0.16	30.70	26	29.38	17
Dutch Harbor	29.74	+.04	30.48	22	28.80	2
St. Paul	29.74	+.01	30.32	21	28.90	11
Kodiak	29.79	+.10	30.52	30	28.88	6
Juneau	29.90	−.04	30.53	29	29.22	16
Tatoosh Island	30.06	+.10	30.41	1	29.67	27
San Francisco	30.01	−.05	30.28	27	29.42	30
Mazatlan	29.90	−.02	29.98	5	29.82	12, 17
Honolulu	30.04	.00	30.17	11	29.80	20
Midway Island	30.21	+.14	30.56	20	29.86	27
Guam	29.90	.00	29.96	2, 11, 12	29.84	4, 15
Manila	29.90	+.04	29.98	25	29.80	5
Hong Kong	30.08		30.28	25	29.93	11
Naha	30.15	+.15	30.36	25	29.98	7
Chichishima	30.11	+.11	30.42	11	29.84	8
Nemuro [1]			30.30	11	29.60	17

[1] For 16 days only.

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

Cyclones and gales.—Along the western half of the northern and middle steamer routes a considerable amount of well-distributed storminess occurred during March. In the early half of the month, several progressive cyclonic storms moved northeastward from the Japanese area into the Aleutian region, developing the lowest pressures of March along their courses. During the last week of the month, settled low pressure, with little progressive movement, lay over an enormous area east of Japan.

From the 1st to 3d, in this region, although barometer readings below 29 inches were taken on several ships, and gales were experienced in scattered positions between 30°–50° N., 145°–175° E., no winds exceeding force 9 were reported.

The deepest cyclone of the month was that which developed suddenly on the 8th near the east Japanese coast. By the 9th, fresh to strong gales were experienced in the northern and southern sectors of the storm, the high winds extending as far eastward as 160° E. On the 10th the Japanese motorship *Hikawa Maru* was at the center of the cyclone near 46° N., 157° E., lowest barometer 28.39—the minimum reported reading of the month. On this day gales of force 10 occurred during the greatest intensity of the cyclone. The storm thereafter moved into Aleutian and Alaskan waters with much abated energy.

Fresh local gales occurred south of Honshu on the 13th and 14th, and fresh to whole gales were experienced by ships to the eastward of central Japan on the 22d.

During the period March 24–31, while low pressure conditions dominated middle and upper waters in east longitudes, local gales of force 11 were reported on the 24th, 26th, and 31st within the region bounded by 30°–50° N., 150°–170° E., and gales of lower force occurred within the same area throughout the last week of the month.

There were fewer days with gales east of the 180th meridian than west of it. The greater number of western Pacific storms weakened upon reaching higher latitudes in midocean. However, there were scattered gales, mostly of force 8–9, to the southward of the eastern Aleutians during the early half of March, and more widely scattered gales over the same region during the latter half, with the highest force reported as 11 from north-northeast, on the 21st, near 35° N., 164° W.

Heavy weather occurred on several days along or near the west coast of the United States. This condition was especially pronounced on the 21st and 22d during the prevalence of strong anticyclonic conditions over the

eastern Pacific coupled with cyclonic conditions over the extreme western part of the United States. On these dates strong northwesterly winds were experienced close in along the central California coast, attaining force 10 on the 21st, as reported by the American steamer *Malolo*, near 38° N., 123° W., and force 11 on the 22d, as reported by the British motorship *Ary Lensen*, in 38° 55′ N., 124° 21′ W. On the 23d and 24th, strong northwesterly gales occurred some 4 or 5 degrees west of the coast of Oregon. On March 30 a fresh northwest gale was reported by a ship near Point Conception.

No tropical storms occurred on the North Pacific this month, but strong northeast trades (force 7) were experienced south of the Hawaiian Islands on the 11th and 12th, and a norther of force 7 occurred near the Gulf of Tehuantepec on the 12th.

Fog.—Fog was reported on 2 days off the Oregon coast; on 7 days off the California coast, and on 1 day near Cape San Lucas. Dense, delaying fog occurred at the mouth of the Columbia River on March 2. Along the northern Pacific routes fog mantled a considerable sea area between 46° and 52° N., 150° and 170° W., on the 27th to 29th. Between latitudes 33°–38° N., longitudes 139°–170° W., fog occurred on 8 days. In east longitudes fog was noted on 4 days near mid-Pacific, and on 3 days off the China coast.

CLIMATOLOGICAL TABLES

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation, by sections, March 1936

[For description of tables and charts, see REVIEW, January, p. 29]

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	59.8	+4.0	Selma No. 1	90	25	Florence	27	18	3.61	−2.14	Madison	7.78	Millry	0.81
Arizona	54.1	+.8	2 stations	95	20	Alpine	−7	29	.98	+.02	Pinal Ranger Station.	4.67	5 stations	.00
Arkansas	57.1	+4.5	Magnolia	88	[1] 15	Dutton	22	17	2.19	−2.55	England	6.03	De Queen	.05
California	52.4	+.9	2 stations	105	[1] 17	Soda Springs	−12	25	1.86	−1.68	2 stations	7.61	3 stations	.00
Colorado	36.9	+2.4	Las Animas	89	13	Hermit (near)	−21	26	.99	−.30	Cascade	4.04	Salida	.02
Florida	65.3	.0	2 stations	92	[1] 26	4 stations	33	[1] 13	3.29	+.16	Inverness	6.89	Palatka	1.36
Georgia	58.9	+2.7	do	92	[1] 24	Blairsville	20	17	4.32	−.56	Athens No. 2	7.01	Quitman	2.15
Idaho	33.0	−2.8	Kooskia	74	20	Deadwood	−24	30	1.45	−.33	Roland	7.51	Howe	T
Illinois	44.8	+4.7	3 stations	81	23	Marengo	5	6	1.70	−1.35	Shawneetown	5.31	Sycamore	.14
Indiana	44.6	+4.0	Shoals	84	30	2 stations	6	10	2.74	−1.01	Mt. Vernon	5.65	Hobart	1.20
Iowa	39.2	+4.7	Keokuk No. 2	80	23	do	−1	31	1.02	−.70	Charles City	3.14	Mt. Ayr	T
Kansas	48.5	+5.2	Liberal	90	9	Tribune	9	24	.14	−1.28	Columbus	1.33	7 stations	.00
Kentucky	50.7	+4.4	2 stations	81	30	Farmers	19	6	4.85	+.12	Russellville	7.79	Louisville	2.99
Louisiana	63.3	+2.7	Urania	93	24	2 stations	30	18	2.07	−2.65	Plain Dealing	3.91	Lake Arthur	.70
Maryland-Delaware	47.2	+5.0	Cumberland, Md	83	30	do	15	2	5.84	+2.27	Grantsville, Md	9.39	Solomons, Md	3.26
Michigan	32.7	+2.9	2 stations	70	24	Vanderbilt	−28	1	1.09	−1.07	Ironwood	4.63	Croswell	.19
Minnesota	26.4	+.1	Winnebago	68	28	Warroad	−32	5	1.50	+.31	Pigeon River Bridge	3.50	Alexandria	.20
Mississippi	60.8	+3.9	3 stations	90	[1] 25	2 stations	28	[1] 13	2.93	−2.83	Booneville	7.32	Biloxi	.70
Missouri	49.4	+5.6	Caruthersville	84	26	Downing	13	6	1.27	−1.99	New Madrid	4.05	Tarkio	T
Montana	30.8	+.1	Ballantine	70	6	Summit	−29	30	.72	−.23	Trout Creek (near)	4.32	Deer Lodge	.03
Nebraska	40.5	+4.2	McCook	85	9	Harrison	−6	30	.57	−.58	Mullen	1.92	5 stations	T
Nevada	43.4	+3.0	Logandale	88	15	Marlette Lake	2	[1] 23	.59	−.38	Marlette Lake	2.41	2 stations	T
New England														
New Jersey	45.3	+6.2	3 stations	78	30	Layton	−1	2	5.28	+1.50	Charlotteburg	9.08	Tuckerton	2.07
New Mexico	44.8	+1.0	Nara Visa (near)	90	20	McGaffey Ranger Station.	−14	24	.32	−.42	Aspen Grove Ranch	2.28	35 stations	.00
New York	39.0	+6.8	Bedford Hills	77	30	Indian Lake	−2	20	5.54	+2.47	Mt. McGregor	9.00	Letchworth Park	1.29
North Carolina	52.6	+2.7	3 stations	88	31	Mt. Mitchell	8	[1] 18	6.22	+1.95	Swansboro	14.32	New Holland	3.50
North Dakota	25.5	+1.2	4 stations	61	[1] 9	Hannah	−27	5	.81	+.08	Howard	2.48	Hettinger	.20
Ohio	43.0	+4.2	Portsmouth	81	30	Hiram	8	6	3.64	+.26	Gallipolis (near)	5.48	Oxford	1.13
Oklahoma	56.3	+5.6	Hugo	91	29	Goodwell	16	24	.31	−1.65	Tishomingo	3.29	18 stations	.00
Oregon	39.8	−1.2	Grants Pass	82	[1] 20	Fall River	−18	31	1.97	−.77	Crossett	11.38	Morgan	.04
Pennsylvania	42.6	+4.9	Greensburg	85	29	Gouldsboro	−3	2	6.84	+3.30	Bakers Summit	10.06	Grove City	3.01
South Carolina	56.5	+1.9	2 stations	90	31	Long Creek	23	22	5.33	+1.42	Landrum	9.72	Orangeburg	2.45
South Dakota	33.7	+2.8	Tyndall	75	9	4 stations	−9	[1] 5	.78	−.33	Arlington	2.11	Bison	T
Tennessee	53.3	+3.9	3 stations	84	[1] 26	Rugby	18	7	6.77	+1.34	Gatlinburg	10.64	Union City	2.86
Texas	62.0	+3.5	Falfurrias	102	23	Romero	16	24	1.02	−1.01	Sinton	4.94	13 stations	.00
Utah	38.4	.0	St. George	81	17	Woodruff	−5	23	1.32	−.07	Silver Lake	4.94	Panguitch	.15
Virginia	49.8	+4.0	Kenbridge	85	30	Big Meadows	17	13	5.83	+2.06	Shenandoah Camp No. 3.	11.92	Mineral	3.17
Washington	39.5	−2.0	4 stations	73	[1] 19	Lake Keechelus	−9	31	3.34	−.34	Big Four	14.65	2 stations	.00
West Virginia	45.3	+2.9	Hastings	86	30	Alpena	10	20	6.21	+2.24	Romeny	9.94	Bens Run	3.62
Wisconsin	30.8	+1.5	Beloit	75	23	Long Lake	−18	1	1.58	−.19	Flambeau Reservoir	3.32	Milwaukee Airport	.18
Wyoming	29.3	−.5	Wheatland	73	9	2 stations	−35	30	1.17	.00	Moose	3.36	Deaver	.20
Alaska (February)	2.4	−4.8	Dutch Harbor	55	16	Fort Yukon	−60	[1] 6	1.05	−.72	Dutch Harbor	9.01	3 stations	.00
Hawaii	69.2	+.3	Molokai Ranch	92	[1] 8	Kanaloholuluhulu	34	21	9.30	+.37	Piihonua	37.30	Waianae Valley	.00
Puerto Rico	73.2	−.1	Mayaguez	95	20	Guineo Reservoir	37	28	1.42	−2.06	Guineo Reservoir	4.80	La Fe	.00

[1] Other dates also.

TABLE 1.—*Coimatological data for Weather Bureau stations, March 1936*

[Compiled by Annie E. Small, by official authority, U. S. Weather Bureau]

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
New England							40.2	+7.2										79	5.83	+2.6										6.5		
Eastport	76	67	85	29.89	29.97	+0.04	36.8	+7.9	55	17	43	8	2	31	20	35	32	86	4.48	+0.6	15	8,688	sw.	41	se.	12	4	6	21	7.5	7.7	0.0
Greenville, Maine	1,070	6	40																												
Portland, Maine	103	82	117	29.82	29.94	−.02	38.2	+6.4	62	29	44	10	2	32	26	34	29	74	7.48	+3.6	18	7,123	n.	38	se.	12	14	4	13	5.4	11.7	.0
Concord	289	60																													
Burlington	403	11	48	29.43	29.89	−.11	36.6	+7.5	63	29	45	−6	2	28	36	33	29	76	3.80	+1.8	17	8,034	s.	38	s.	4	7	8	16	6.9	3.8	.0
Northfield	876	12	60	28.94	29.91	−.09	34.2	+7.8	64	30	45	−14	2	24	43	31	27	79	6.05	+3.5	19	5,752	s.	25	sw.	31	5	7	19	7.5	2.9	T
Boston [1]	29	31	50	29.89	29.92	−.05	41.8	+6.2	70	31	49	15	7	34	33	37	32	75	6.40	+2.8	12	7,932	e.	31	w.	28	9	7	15	6.5	2.9	.0
Nantucket	12	14	90	29.92	29.92	−.06	43.2	+7.7	60	30	49	25	7	38	17	40	37	83	4.27	+.5	13	11,992	s.	41	sw.	13	9	9	13	6.0	T	.0
Block Island	26	11	46	29.88	29.91	−.07	40.2	+4.8	61	30	46	21	7	35	20	38	35	86	6.50	+2.7	15	11,509	s.	43	nw.	22	7	11	13	6.4	2.6	.0
Providence	160	215	251	29.75	29.93	−.05	43.8	+8.1	70	31	52	15	7	36	34	38	33	75	6.78	+3.3	13	9,390	nw.	47	se.	18	12	7	12	5.6	3.2	.0
Hartford	159	70	104	29.74	29.92	−.07	43.4	+8.4	71	30	52	10	8	35	29				6.10	+2.2	16	6,500	s.	37	nw.	22	7	9	15	6.5	5.5	.0
New Haven	106	74	153	29.81	29.92	−.07	43.4	+7.6	65	30	51	14	7	26	27	39	34	76	6.43	+2.3	16	7,134	s.	30	nw.	22	8	10	13	6.4	3.3	.0
Middle Atlantic States							47.2	+6.5										74	4.81	+1.3										6.9		
Albany	97	97	112	29.80	29.90	−.11	42.3	+9.6	73	29	51	6	2	33	37	38	33	74	5.39	+2.8	18	5,658	s.	30	se.	11	8	8	15	6.7	.3	.0
Binghamton	871	57	79	28.95	29.90	−.12	40.7	+8.1	69	30	50	4	2	31	35				6.24	+3.6	20	5,151	ne.	30	nw.	22	2	8	21	8.2	5.1	.0
New York	314	415	454	29.55	29.90	−.10	45.3	+7.6	72	30	53	17	7	38	26	40	35	72	3.97	+.3	16	10,945	s.	65	nw.	22	8	9	14	6.3	1.2	.0
Harrisburg	374	94	104	29.47	29.88	−.15	45.2	+6.3	73	30	53	16	2	37	28	40	34	70	6.61	+3.6	12	6,147	ne.	30	nw.	22	4	10	17	7.2	4.8	.0
Philadelphia	114	174	367	29.78	29.91	−.11	48.3	+7.5	75	30	57	24	2	40	28	42	37	72	4.02	+.6	14	9,616	s.	41	se.	17	5	9	17	6.6	T	.0
Reading	3	283	306	29.54	29.90		46.1	+6.1	74	30	55	16	2	38	31	41	35	70	4.77	+1.2	17	9,019	se.	45	nw.	22	5	10	16	6.7	2.4	.0
Scranton	805	72	104	29.01	29.89	−.13	43.4	+7.7	74	30	53	13	2	34	35	38	32	71	5.25	+2.0	17	5,211	sw.	32	nw.	22	3	13	15	7.1	1.7	.0
Atlantic City	52	37	172	29.84	29.90	−.12	43.8	+5.2	73	31	50	24	2	38	28	40	37	80	3.87	+.3	16	13,007	s.	46	e.	11	5	7	19	7.0	T	.0
Sandy Hook	22	10	57	29.87	29.89		42.8		67	30	49	22	7	37	24	39	36	82	3.40	−.6	16	10,026	s.	49	nw.	22	5	11	15	6.3	.2	.0
Trenton	190	88	106	29.69	29.90		46.4	+7.3	75	30	56	19	2	37	32	41	37	76	3.78	−.1	14	7,603	s.	33	se.	17	5	9	17	6.9	T	.0
Baltimore	123	100	215	29.76	29.89	−.14	48.8	+6.5	75	29	57	24	2	41	28	43	39	74	6.42	+2.7	15	7,953	se.	34	s.	17	6	8	17	7.0	1.6	.0
Washington	112	62	85	29.76	29.88	−.16	50.3	+7.7	76	30	60	26	2	41	44	43	37	68	4.47	+.7	14	5,834	nw.	34	nw.	21	5	10	16	7.0	T	.0
Cape Henry	18	8	54	29.88	29.90		51.6	+5.0	81	24	60	33	2	43	38	46	42	78	3.82	.0	16	8,650	sw.	32	nw.	21	8	8	15	6.4	T	.0
Lynchburg	686	5			29.90	−.15	51.4	+4.1	79	31	64	28	2	39	46				7.48	+3.9	16		nw.				5	18	8		3.0	.0
Norfolk	91	80	125	29.81	29.91	−.12	53.8	+5.6	83	31	63	32	2	45	31	47	43	74	3.83	+.1	16	8,152	sw.	43	se.	17	4	11	16	7.0	T	.0
Richmond	144	11	52	29.75	29.90	−.14	52.4	+5.2	82	31	63	27	2	42	43	45	40	72	3.83	+.2	12	7,184	sw.	34	nw.	21	8	8	15	6.5	.0	.0
Wytheville	2,304	49	55		29.89	−.16	46.2	+3.9	71	30	57	24	18	36	35			70	4.59	+1.2	15	5,746	w.	30	w.	12	10	9	12		7.2	.0
South Atlantic States							57.6	+3.8										74	5.63	+1.9										5.9		
Asheville	2,253	89	104	27.56	29.93	−.13	49.0	+4.1	75	30	60	24	18	38	36	41	35	68	6.42	+2.4	15	7,554	nw.	38	nw.	17	7	10	14	6.2	12.2	.0
Charlotte	779	63	86	29.07	29.92	−.13	55.0	+4.6	83	31	65	32	17	45	32	47	42	69	7.12	+3.0	15	6,413	s.	30	nw.	24	8	9	14	6.2	T	.0
Greensboro	886	6	56	28.94	29.91		50.8		79	31	62	30	8	40	36	44	41	78	4.95		16	7,013	sw.	34	nw.	21	7	7	17	6.7	.5	.0
Hatteras	11	5	50	29.91	29.92	−.12	56.0	+4.0	72	31	62	37	1	50	20	52	50	84	7.24	+3.0	13	10,426	sw.	49	w.	12	9	9	13	5.7	.0	.0
Raleigh	376	103	146	29.49	29.90	−.15	55.2	+5.0	84	31	65	32	2	45	28	50	47	81	4.46	+.6	16	7,032	sw.	38	nw.	12	7	13	11	5.9	T	.0
Wilmington	72	73	107	29.86	29.93	−.12	57.8	+4.5	84	31	66	36	18	49	27	52	47	76	10.43	+7.3	12	7,810	s.	37	sw.	17	12	6	13	5.7	.0	.0
Charleston	48	11	92	29.88	29.93	−.13	59.9	+2.5	83	31	68	39	17	52	30	54	50	77	5.51	+2.5	8	8,094	w.	34	ne.	10	7	10	14	6.1	.0	.0
Columbia, S. C	347	67	73	29.54	29.92	−.14	58.6	+3.4	87	31	69	35	17	48	30	50	44	67	5.36	+2.0	14	5,711	s.	28	w.	12	13	6	12	5.4	T	.0
Greenville, S. C	1,039	139					54.1	+4.2	74	31	64	34	9	45	30				4.43	−.7	11		sw.				14	7	10			.0
Augusta	182	62	77	29.72	29.91	−.15	60.0	+4.0	86	31	71	35	17	48	34	51	44	67	4.37	+.3	13	5,264	nw.	27	nw.	24	8	11	12	5.7	T	.0
Savannah	65	73	152	29.87	29.94	−.12	62.8	+3.8	87	31	72	39	17	53	32	54	49	73	3.67	+.6	9	9,575	s.	44	w.	17	10	12	9	5.5	.0	.0
Jacksonville	43	86	110	29.92	29.97	−.09	64.7	+2.1	87	26	74	43	18	56	29	56	51	72	2.93	.0	10	6,708	w.	30	w.	17	9	13	9	5.3	.0	.0
Florida Peninsula							69.6	−0.2										77	3.53	+1.5										5.1		
Key West	22	10	64	29.96	29.98	−.07	71.8	−.8	85	30	78	54	22	66	22	66	63	79	4.36	+3.0	6	8,076	se.	37	nw.	17	15	12	4	3.9	.0	.0
Miami	25	124	168	29.97	30.00	−.08	70.3	+.1	84	29	77	50	18	64	25	64	60	74	3.71	+1.5	10	7,678	se.	45	s.	9	9	14	8	5.5	.0	.0
Tampa	35	88	197	29.94	29.98	−.09	66.8	.0	84	30	74	48	18	60	24	60	56	78	2.53	+.1	10	8,321	s.	34	nw.	17	11	5	15	5.9	.0	.0
Titusville	43	5	36	29.92	29.97		66.1		88	30	76	41	19	56	32				4.33		8		w.				11	6	14		.0	.0
East Gulf States							61.4	+3.8										71	2.77	−2.4										5.5		
Atlanta [1]	976	5	53	28.90	29.92	−.14	56.5	+4.5	82	26	68	32	19	45	40	48	42	69	4.22	−1.1	10	7,521	nw.	43	nw.	17	10	10	11	5.5	T	.0
Macon	370	79	87	29.54	29.94	−.12	59.9	+3.2	84	31	72	36	17	48	36	50	43	62	3.06	−1.9	10	6,151	s.	32	nw.	17	13	7	11	5.0	T	.0
Thomasville	273	49	58	29.68	29.96	−.10	63.0	+2.8	85	31	74	39	18	52	32	56	52	77	3.15	−.9	8		sw.					8	10	13		.0	.0
Apalachicola	36	11	51	29.94	29.98		63.0		79	31	70	43	18	56	22	57			2.95	−1.3	12		s.				7	8	16			.0
Pensacola	56	149	185	29.91	29.97	−.09	62.2	+1.9	77	10	68	40	18	56	25	58	55	83	2.78	−2.0	10	9,899	se.	35	nw.	20	10	8	13	5.5	.0	.0
Anniston	741	9					58.5	+6.0	83	26	71	32	21	46	38				3.82	−1.8	8		nw.				15	11	5		.0	.0
Birmingham	700	11	48	29.17	29.94	−.12	59.4	+4.0	84	26	70	34	18	49	35	50	43	64	2.87	−2.8	7	6,495	nw.	26	nw.	20	11	10	10	5.2	.0	.0
Mobile	57	86	105	29.90	29.96	−.10	63.0	+3.3	79	30	72	40	18	54	28	56	52	76	1.52	−4.5	10	6,335	s.	36	nw.	16	8	9	14	6.0	.0	.0
Montgomery	218	92	105	29.71	29.96	−.10	62.0	+4.2	87	26	73	38	18	51	37	52	44	62	2.08	−3.9	7	6,236	se.	31	nw.	16	10	10	11	5.6	.0	.0
Meridian	375	67	92	29.55	29.94	−.11	61.6	+4.5	87	26	73	37	18	50	36	52	46	66	1.96	−3.3	7	5,635	sw.	26	nw.	20	12	9	10	5.1	.0	.0
Vicksburg	247	65	73	29.68	29.94	−.10	63.0	+4.5	86	25	73	42	17	53	30	53	45	60	2.60	−3.0	9	6,376	s.	26	nw.	19	11	6	14	5.6	.0	.0
New Orleans	53	76	84	29.91	29.97	−.07	65.8	+3.0	83	25	74	47	18	57	32	58	54	75	2.25	−2.5	8	5,587	se.	24	nw.	16	10	8	13	6.2	.0	.0
West Gulf States							63.2	+4.0										65	1.65	−1.3										5.0		
Shreveport	249	92	227	29.65	29.92	−.10	63.7	+5.4	87	15	74	42	17	53	31	54	46	60	2.65	−1.5	6	8,990	s.	34	nw.	19	13	13	5	4.6	.0	.0
Bentonville	1,303	12	38	28.53	29.90	−.11	53.0	+5.7	71	29	65	31	31	41	32				1.16	−2.4	7	6,338	s.	26	sw.	22	10	10	11		T	.0
Fort Smith	457	79	94	29.41	29.89	−.12	57.8	+5.2	83	29	69	37	12	46	36	47	36	51	.75	−2.3	5	7,020	e.	26	sw.	13	13	11	7	4.7	.0	.0
Little Rock	357	94	102	29.54	29.92	−.11	58.0	+5.0	80	29	68	37	13	48	33	48	39	55	2.35	−2.3	6	7,396	sw.	27	sw.	13	15	7	9	4.4	.0	.0
Austin	605	136	148	29.27	29.90		65.4	+4.7	90	14	77	42	12	54	38	54	46	59	1.52	−.8	4	6,451	s.	31	n.	16	11	8	13	4.7	.0	.0
Brownsville	57	88	96	29.82	29.88		69.4	+1.2	88	16	77	51	17	62	28	63	61	83	.58	−.7	5	8,012	se.	32	n.	11	8	12	11	6.0	.0	.0
Corpus Christi	20	11	78	29.88	29.90	−.08	67.9	+2.9	91	14	74	52	17	61	31	62	59	82	3.29	+1.7	5	8,003	s.	34	s.	22	10	11	10	5.5	.0	.0
Dallas	512	220	227	29.34	29.88		62.6		90	14	74	39	17	52	35	51	39	49	.90	−2.0	4	9,702	s.	36	nw.	19	14	10	7	4.1	.0	.0
Fort Worth	679	92	110	29.19	29.90	−.08	62.7	+5.0	90	14	75	37	17	51	38				.63	−1.7	4	8,175	n.	40	n.	16	23	7	1		.0	.0
Galveston	54	106	114	29.88	29.94	−.07	64.7	+2.3	78	24	70	51	17	60	19	61	59	87	1.89	−.8	8	7,826	s.	28	se.	8	8	13	10	5.6	.0	.0
Houston	138	292	314	29.79	29.94		66.0	+2.7	86	23	75	46	17	58	28				2.31	−1.2	8	9,073	s.	38	n.	16	8	9	14	5.7	.0	.0
Palestine	510	64	72	29.39	29.92	−.08	63.6	+4.5	88	23	75	42	17	53	34	54	47	62	1.27	−2.2	7	6,358	s.	25	s.	22	15	9	7	4.4	.0	.0
Port Arthur	34	58	66	29.91	29.95		65.2		83	24	73	45	12	57	25				1.09	−2.2	8	6,204	s.	29	n.	16	9	12	10	5.6	.0	.0
San Antonio	693	242	301		29.89	−.09	66.3	+3.5	90	23	76	45	17	56	34			60	2.66	+.8	5	7,667	s.	41	se.	18	8	13	10		.0	.0

[1] Observations taken at airport.

TABLE 1.—*Climatological data for Weather Bureau stations, March 1936*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Ohio Valley and Tennessee	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	*°F.*	*°F.*	*°F.*		*°F.*	*°F.*		*°F.*	*°F.*	*°F.*	*°F.*	*X*	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
				48.5			56.7	+4.2										67	4.68	+0.5										6.0		
Chattanooga	762	71	214	29.11	29.93	−0.13	56.7	+5.5	81	26	67	35	18	46	34	48	40	61	5.04	−0.7	12	7,030	w.	38	nw.	20	10	12	9	5.0	T	0.0
Knoxville	995	66	84	28.86	29.92	−.14	52.7	+4.0	78	30	63	29	19	42	34	46	40	72	7.96	+2.9	13	4,927	w.	27	nw.	2	7	12	12	5.6	2.6	.0
Memphis	399	78	86	29.49	29.91	−.13	57.4	+5.1	80	26	67	36	17	48	29	48	40	59	4.12	−1.1	7	7,135	s.	35	sw.	24	16	7	8	4.1	.0	.0
Nashville	546	168	191	29.35	29.94	−.11	53.8	+4.6	75	30	64	32	18	43	32	45	38	61	8.40	+3.3	13	8,306	nw.	46	nw.	17	10	7	14	5.5	T	.0
Lexington	989	6	----	----	----	----	48.0	+4.3	73	30	59	25	6	37	34	----	----	----	4.43	+.1	10	----	s.	----	----	----	13	4	14	----	2.1	.0
Louisville	525	188	234	29.33	29.92	−.13	50.0	+4.6	77	30	60	22	6	39	35	43	36	63	2.99	−1.4	10	9,386	s.	46	n.	17	7	15	9	5.5	2.8	.0
Evansville	431	76	116	29.44	29.91	−.13	49.9	+4.0	75	30	60	27	6	40	35	42	35	62	4.67	+.5	11	7,923	s.	34	nw.	12	11	11	9	5.2	T	.0
Indianapolis	822	194	230	29.01	29.90	−.14	44.3	+4.3	73	30	54	17	6	34	40	38	31	64	2.13	−1.8	12	9,289	w.	39	w.	12	9	12	10	6.1	2.8	.0
Terre Haute	575	96	129	29.26	29.89	----	46.5	----	74	29	57	20	6	36	39	40	34	67	2.81	−1.0	11	8,195	sw.	37	w.	12	10	12	9	5.5	4.9	.0
Cincinnati	627	11	51	29.22	29.90	−.15	46.8	+5.9	78	30	58	19	6	36	34	40	34	67	2.55	−1.3	13	7,052	s.	29	n.	17	7	9	15	6.4	1.2	.0
Columbus	822	90	210	29.01	29.90	−.14	43.8	+4.7	76	30	53	18	6	34	37	39	33	69	3.10	−.4	17	8,467	s.	41	n.	17	7	9	15	6.3	2.8	.0
Dayton	900	58	153	28.92	29.88	----	44.8	+4.3	76	30	55	19	6	35	36	----	----	----	2.94	−.8	13	7,761	sw.	33	w.	12	5	15	11	6.4	5.5	.0
Elkins	1,947	59	78	27.85	29.94	−.11	42.3	+2.3	74	30	54	15	20	31	43	37	33	78	8.32	+4.5	15	4,874	w.	27	w.	13	2	12	17	7.6	29.8	.0
Parkersburg	637	77	84	29.27	29.93	−.12	46.0	+3.2	77	30	56	22	1	36	36	40	34	69	4.83	+1.3	17	5,585	nw.	28	nw.	17	7	6	18	6.5	11.3	.0
Pittsburgh [1]	842	164	410	28.50	29.87	−.17	42.2	+2.6	75	30	51	15	6	33	33	37	32	75	5.88	+2.8	18	8,964	sw.	34	sw.	27	4	8	19	7.6	9.6	.0
Lower Lake Region							37.8	+4.8										76	4.35	+1.7									7.0		
Buffalo	768	243	280	29.03	29.88	−.14	35.0	+3.9	59	27	42	9	6	28	25	32	29	80	7.03	+4.5	19	11,614	sw.	61	sw.	13	4	8	19	7.5	38.5	.0
Canton	448	10	61	29.38	29.87	----	33.8	+6.1	61	29	43	−8	2	25	37	31	28	84	2.94	+.4	20	7,517	w.	34	sw.	27	4	9	18	7.3	12.8	.0
Ithaca	836	77	100	28.97	29.89	----	38.4	+6.6	65	29	47	7	2	30	31	34	30	75	6.92	+4.6	18	7,366	nw.	32	se.	2	3	6	22	7.9	10.5	.0
Oswego	335	71	85	29.51	29.88	−.13	35.9	+4.7	65	29	42	5	2	29	29	32	28	79	5.61	+3.0	18	8,210	se.	30	n.	18	5	4	22	7.8	12.3	.0
Rochester	523	86	102	29.31	29.89	−.13	37.3	+5.5	68	27	44	12	6	30	28	34	30	78	6.55	+3.8	18	6,854	w.	37	sw.	27	5	7	19	7.3	19.2	.0
Syracuse	596	65	79	29.25	29.90	−.12	39.0	+7.6	68	29	47	7	2	31	30	----	----	----	5.97	+3.0	22	5,796	w.	26	w.	22	4	6	21	7.7	8.8	.0
Erie	714	130	166	29.10	29.88	−.14	37.7	+4.2	68	27	45	12	6	31	25	34	30	77	3.80	+1.2	16	10,366	w.	38	se.	27	6	8	17	6.8	20.4	.0
Cleveland	762	267	318	29.04	29.88	−.15	39.5	+4.9	68	30	47	11	6	32	34	36	31	74	3.28	+.6	16	12,445	w.	51	n.	18	4	10	17	7.1	10.1	.0
Sandusky	629	5	67	29.19	29.89	−.14	39.5	+4.4	68	24	48	11	6	31	27	----	----	----	3.87	+1.2	15	7,548	sw.	30	sw.	27	5	13	13	6.7	3.6	.0
Toledo	628	79	87	29.20	29.89	−.14	39.3	+4.0	68	24	48	12	6	31	30	34	29	71	1.90	−.6	12	7,982	w.	31	sw.	27	7	16	8	5.7	1.9	.0
Fort Wayne	857	69	84	28.95	29.89	----	40.6	+1.7	66	29	50	13	6	31	32	35	30	71	3.03	−.2	12	7,761	w.	28	w.	27	9	10	12	5.9	3.5	.0
Detroit [1]	626	5	78	29.19	29.88	−.15	37.6	+4.2	67	24	45	10	6	30	28	32	28	75	1.28	−1.1	10	8,243	nw.	44	sw.	27	6	9	16	6.4	1.7	.0
Upper Lake Region							31.7	+3.4										76	1.42	−0.7									6.9		
Alpena	609	13	89	29.19	29.87	−.16	30.2	+4.7	52	24	37	−7	1	23	28	27	23	79	1.46	−.5	12	8,875	nw.	34	nw.	4	7	9	15	6.6	10.3	1.0
Escanaba	602	54	60	29.18	29.86	−.18	27.2	+3.0	50	24	34	−10	1	20	33	24	20	77	1.73	−.2	13	7,051	s.	31	nw.	4	7	7	17	6.7	9.5	.0
Grand Rapids	707	70	244	29.09	29.88	−.15	37.2	+3.8	69	24	46	7	1	29	28	32	27	71	.73	−1.8	11	9,001	sw.	45	sw.	24	4	9	18	7.0	3.0	.0
Lansing	878	5	90	28.91	29.87	----	35.9	+3.7	69	24	44	8	6	27	27	31	26	72	.83	−1.5	12	8,048	w.	33	sw.	27	6	7	18	7.1	5.0	.0
Ludington	637	5	54	29.15	29.86	----	33.4	+3.3	61	23	40	0	1	26	28	30	----	----	.61	−1.7	9	----	se.	----	----	----	7	13	11	----	3.5	.5
Marquette	734	77	111	29.02	29.84	−.20	27.6	+2.8	54	24	35	0	5	20	31	25	22	83	2.89	+.6	17	6,558	w.	31	nw.	4	5	11	15	6.6	13.8	10.0
Sault Sainte Marie	614	11	52	29.16	29.88	−.15	25.4	+3.8	42	21	33	−12	6	18	30	23	21	83	2.21	+.4	21	7,390	se.	38	nw.	4	5	10	16	6.9	13.2	T
Chicago	673	7	131	29.15	29.89	−.14	39.6	+4.3	72	23	47	14	6	32	27	34	29	69	1.00	−1.6	12	8,592	w.	35	se.	26	7	13	11	6.3	2.0	.0
Green Bay	617	109	141	29.16	29.84	−.20	31.9	+3.3	64	23	40	1	1	24	29	28	23	72	1.18	−.9	10	8,036	w.	35	w.	27	5	5	21	7.5	7.8	.0
Milwaukee	681	97	221	29.11	29.86	−.17	36.5	+4.4	69	23	44	8	6	29	31	32	27	71	.67	−1.8	9	9,671	w.	39	sw.	24	6	9	16	6.9	1.9	.2
Duluth	1,133	5	47	28.57	29.83	−.23	24.0	+.3	45	20	31	−14	5	17	24	22	19	83	2.36	+.8	15	9,829	w.	41	nw.	29	5	6	20	7.6	19.9	2.2
North Dakota							25.2	+2.8										83	1.05	+0.2									6.6		
Moorhead, Minn	940	50	58	28.83	29.88	−.20	24.0	+1.3	48	19	32	−13	5	16	36	22	20	86	1.31	+.3	10	7,636	nw.	27	n.	3	2	8	21	7.8	13.1	2.5
Bismarck	1,674	8	57	28.06	29.90	−.16	28.2	+4.0	55	17	36	0	5	20	31	26	22	79	.88	.0	6	7,755	nw.	30	nw.	20	5	13	13	6.3	11.6	1.2
Devils Lake	1,478	11	44	28.26	29.88	−.17	22.6	+2.8	44	19	31	−16	5	15	38	21	19	80	.51	−.3	10	8,510	w.	33	nw.	3	4	8	19	7.2	5.5	.8
Grand Forks	833	12	67	----	----	----	21.1	----	42	18	30	−22	5	12	37	19	----	----	1.09	----	13	----	nw.	38	nw.	3	2	20	9	----	6.6	7.3
Williston	1,878	41	48	27.88	29.91	−.13	25.9	+3.0	55	17	34	−8	31	18	33	24	20	78	1.51	+.8	12	7,305	w.	35	w.	7	10	14	7	5.2	18.2	9.0
Upper Mississippi Valley							40.6	+4.3										69	2.05	−0.3									6.0		
Minneapolis	919	105	208	28.84	29.85	----	29.9	+0.3	56	28	37	−6	5	23	35	27	23	77	2.66	+1.2	11	8,851	w.	33	nw.	12	1	11	19	7.8	16.5	T
La Crosse	714	11	48	29.07	29.86	−.18	34.5	+3.0	69	23	43	4	6	26	39	30	25	76	2.45	+.8	13	5,083	nw.	23	sw.	24	5	11	15	6.8	9.4	.9
Madison	974	70	78	28.78	29.86	−.18	35.2	+4.6	72	23	43	4	6	27	30	31	27	77	.61	−1.5	10	7,251	nw.	31	s.	23	5	11	15	7.0	2.4	.0
Charles City	1,015	10	51	28.77	29.88	−.17	34.0	+3.3	71	23	42	5	6	26	39	29	26	76	3.14	+1.4	11	6,679	w.	27	sw.	24	8	9	14	6.1	1.6	.0
Davenport	606	66	161	29.22	29.89	−.14	40.8	+4.7	77	23	50	14	6	32	28	35	28	66	1.25	−1.1	10	8,702	nw.	40	sw.	23	8	11	12	6.0	2.6	.0
Des Moines	861	5	99	28.96	29.88	−.16	41.3	+5.4	75	23	52	17	6	31	35	35	29	65	1.57	−.2	4	9,005	n.	39	nw.	12	8	10	13	5.8	T	.0
Dubuque	700	60	79	29.11	29.87	−.17	38.2	+4.2	76	23	47	9	6	29	36	32	27	68	.81	−1.2	11	5,759	nw.	23	se.	26	8	8	15	6.6	3.0	T
Keokuk	614	64	78	29.24	29.92	−.11	43.8	+4.9	78	23	55	17	6	33	32	36	28	59	1.01	−1.4	4	7,254	n.	38	nw.	12	11	8	12	5.7	T	.0
Cairo	358	87	93	29.52	29.91	−.13	52.8	+5.6	76	26	63	29	6	42	33	45	39	67	4.04	+.3	11	8,135	s.	33	s.	24	10	12	9	5.5	T	.0
Peoria	609	11	45	29.23	29.91	−.12	41.9	+4.9	78	23	52	17	6	32	31	36	30	70	1.80	−.9	10	6,556	se.	26	w.	12	13	6	12	5.0	.9	.0
Springfield, Ill	636	5	191	29.21	29.89	−.14	45.0	+4.8	78	23	55	21	6	35	31	39	34	71	3.61	+.4	8	9,847	w.	44	nw.	12	9	11	11	5.5	1.2	.0
St. Louis	568	179	303	29.28	29.90	−.13	49.2	+5.4	74	3	59	24	6	39	33	41	33	59	1.67	−1.7	6	10,130	nw.	47	sw.	22	14	9	8	4.1	T	.0
Missouri Valley							44.5	+5.9										63	0.64	−1.3									4.6		
Columbia, Mo	784	6	84	29.06	29.91	−.12	48.2	+5.6	78	23	60	21	6	36	36	----	----	----	2.20	−.7	6	7,717	w.	32	w.	12	14	10	7	4.4	T	.0
Kansas City [1]	750	32	45	29.07	29.89	−.13	48.9	+6.2	79	23	62	20	31	36	40	39	30	55	.08	−2.4	2	9,121	sw.	38	w.	26	10	14	7	4.8	T	.0
St. Joseph	967	11	49	28.84	29.88	----	47.0	----	78	23	59	18	31	35	37	38	28	54	.14	−1.9	1	8,302	nw.	34	nw.	11	15	11	5	3.7	.0	.0
Springfield, Mo	1,324	98	104	28.48	29.89	−.13	50.9	+5.7	78	29	62	27	31	40	36	42	33	57	1.29	−2.1	5	8,826	s.	32	s.	23	19	8	4	3.2	.0	.0
Iola	984	11	50	28.85	29.90	−.11	52.4	+7.9	80	23	67	23	31	38	44	----	----	----	.18	−2.4	2	----	se.	----	----	----	11	17	3	----	.0	.0
Topeka	987	65	87	----	----	----	49.0	+6.4	81	23	63	19	31	35	40	----	----	----	.25	−1.8	2	8,357	w.	32	s.	22	17	11	3	3.6	T	.0
Lincoln	1,189	11	81	28.59	29.88	−.14	44.3	+6.8	75	22	56	18	31	32	40	35	26	58	.18	−1.1	4	8,796	n.	40	nw.	11	10	17	4	4.5	T	T
Omaha	1,105	170	200	28.82	29.89	−.15	42.4	+5.4	75	23	54	16	31	31	38	35	29	66	.84	−.5	3	9,474	nw.	41	nw.	11	12	13	6	4.5	T	.0
Valentine	2,598	47	54	27.17	29.93	−.10	36.2	+3.9	73	9	48	4	30	24	43	30	22	63	.95	−.1	8	8,110	nw.	27	n.	18	6	15	10	6.1	10.7	6.6
Sioux City	1,138	64	106	28.64	29.88	−.17	38.8	+6.1	73	28	48	13	31	29	41	33	27	7	.30	−.8	4	8,379	nw.	40	nw.	11	8	10	13	6.1	2.1	.8
Huron	1,307	59	74	28.47	29.90	−.16	33.5	+4.6	67	9	43	7	5	24	40	29	25	78	.68	−.2	11	7,657	nw.	36	nw.	11	11	12	8	5.2	8.6	.4
Northern Slope							32.9	+1.5										62	0.85	−0.1									6.5		
Havre	2,505	11	67	27.26	29.96	−.04	30.4	+3.3	59	6	40	−11	29	20	35	26	20	71	.59	+.1	9	7,948	sw.	32	nw.	9	8	13	10	6.1	9.0	3.4
Helena	4,124	85	111	25.71	29.99	−.02	31.8	−.6	60	20	41	−13	30	23	27	26	16	53	.45	−.3	7	7,363	sw.	35	sw.	13	0	12	19	8.1	8.0	5.2
Missoula	3,263	80	91	----	----	----	35.4	----	66	20	44	5	31	27	35	----	----	----	.54	−.4	12	5,798	sw.	37	e.	29	1	6	24	8.3	2.8	T
Kalispell	2,973	48	56	----	29.98	−.01	32.5	−.4	57	20	41	3	29	24	28	----	----	70	1.50	+.6	12	5,291	sw.	27	w.	21	2	18	11	----	17.9	13.0
Miles City	2,371	48	55	27.37	29.97	−.05	34.2	+5.6	59	17	43	3	30	26	27	29	23	65	.21	−.6	10	5,944	s.	30	w.	9	8	12	11	6.0	1.3	T
Rapid City	3,259	50	58	26.49	29.98	−.03	35.0	+2.4	65	9	46	−6	30	24	37	29	21	60	.82	−.2	5	7,297	nw.	32	n.	9	5	19	7	5.8	12.5	6.3
Cheyenne	6,094	50	71	23.79	29.90	−.06	33.2	+.1	63	9	46	0	30	20	43	27	17	56	1.17	+.2	11	12,583	nw.	49	nw.	27	6	12	13	6.2	13.5	.8
Lander	5,372	60	68	24.51	29.93	−.06	33.6	+1.2	65	5	48	1	24	20	42	26	16	54	1.32	+.1	5	5,125	sw.	46	sw.	12	7	19	5	5.3	14.3	3.1
Sheridan	3,790	10	47	25.99	29.97	----	32.6	----	62	6	44	−17	30	21	36	27	19	63	1.48	+.3	10	4,901	nw.	30	nw.	28	6	13	12	6.2	15.2	6.5
Yellowstone Park	6,241	12	46	23.74	30.03	+.01	24.8	−1.7	48	20	34	−13	30	15	36	21	15	66	.71	−1.0	14	7,617	sw.	36	sw.	27	2	12	17	7.8	15.3	10.0
North Platte	2,821	11	51	26.93	29.89	−.11	40.2	+3.6	77	9	54	15	31	27	46	32	22	57	.57	−.3	5	7,230	n.	28	ne.	26	10	12	9	5.3	4.3	1.1

[1] Observations taken at airport.

TABLE 1.—*Climatological data for Weather Bureau stations, March 1936*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
Middle Slope							**47.9**	**+4.6**										**43**	**0.42**	**−0.8**										**4.1**		
Denver	5,292	106	113	24.58	29.87	−.08	41.2	+1.9	73	9	53	12	30	29	44	31	17	44	1.95	+.9	1	16,688	s.	30	nw.	10	7	16	8	5.4	15.1	0.8
Pueblo	4,685	80	86	25.15	29.84	−.08	44.9	+3.3	76	9	60	16	24	30	48	33	17	39	.14	−.4	4	6,314	e.	36	nw.	28	14	15	2	4.5	.7	.0
Concordia	1,392	50	58	28.42	29.92	−.09	46.3	+5.3	79	9	60	19	31	33	44	36	25	51	.15	−1.1	1	7,580	w.	32	nw.	26	13	14	4	4.4	T	.0
Dodge City	2,509	10	86	27.28	29.90	−.07	48.0	+5.2	79	9	63	21	31	33	43	35	20	39	.10	−.8	3	10,512	n.	38	s.	21	18	13	0	2.7	.1	T
Wichita	1,358	85	93	28.44	29.87	−.12	51.0	+5.9	78	22	64	21	31	38	39	40	25	42	T	−1.8	0	9,665	sw.	41	sw.	22	15	10	6	3.8	.0	.0
Oklahoma City	1,214	10	47	28.60	29.88	−.10	56.2	+6.2	81	22	69	32	31	43	36	44	31	45	.21	−1.8	1	8,446	s.	30	sw.	23	14	12	5	3.9	.0	.0
Southern Slope							**58.2**	**+3.6**										**41**	**0.48**	**−0.4**										**4.0**		
Abilene	1,738	10	52	28.09	29.89	−.07	61.2	+4.7	86	14	74	38	12	48	38	46	30	40	.94	−.4	3	8,106	s.	31	s.	21	14	9	8	4.6	.0	.0
Amarillo	3,676	10	49	26.15	29.87	−.08	52.2	+5.3	78	18	66	25	31	38	39	38	22	36	T	−.7	0	8,218	sw.	32	w.	23	18	11	2	2.9	.0	.0
Del Rio	960	63	71	28.88	29.86	−.09	65.3	+1.8	91	14	77	44	28	53	41	54	44	56	.89	+.2	2	6,509	se.	29	nw.	19	10	9	12	5.6	.0	.0
Roswell	3,566	75	85	26.26	29.86	−.04	53.9	+2.6	78	21	69	26	24	38	42	39	20	32	.09	−.6	2	7,394	s.	35	sw.	25	18	10	3	2.7	.0	.0
Southern Plateau							**53.4**	**+2.7**										**41**	**0.21**	**−0.3**										**3.2**		
El Paso	3,778	152	175	26.11	29.87	−.01	58.0	+2.2	77	21	70	34	27	46	31	42	23	30	T	−.4	0	9,534	w.	46	w.	31	17	9	5	3.4	.0	.0
Albuquerque	4,972	5	39	24.95	29.84	.....	47.1	.....	73	18	64	16	27	30	46	35	19	40	.11	−.3	4	8,123	w.	42	w.	31	13	14	4	3.8	.1	.0
Santa Fe	7,013	38	53	23.14	29.86	−.03	41.2	+1.5	62	20	54	15	26	29	35	32	20	46	.63	−.2	4	5,581	n.	27	sw.	31	19	8	4	3.4	5.5	.0
Flagstaff	6,907	10	59	23.25	29.86	−.05	37.1	+1.2	63	15	52	0	26	22	41	29	----	60	1.63	.....	6	7,217	sw.	35	sw.	31	8	18	5	----	7.5	T
Phoenix	1,108	10	107	28.72	29.86	−.05	64.6	+3.9	90	19	79	38	23	50	39	48	30	34	.50	−.2	3	4,736	e.	35	sw.	22	21	2	8	3.3	.0	.0
Yuma	141	9	54	29.73	29.88	−.06	67.6	+3.5	94	20	83	38	27	52	40	51	32	34	T	−.3	0	5,127	w.	29	nw.	22	23	6	2	2.2	.0	.0
Independence	3,957	5	26	25.91	29.94	.00	52.2	+3.7	76	9	67	23	23	37	41	38	----	----	.02	−.5	1	.....	nw.	----	----	----	21	6	3	----	.0	.0
Middle Plateau							**42.3**	**+1.4**										**51**	**0.57**	**−0.2**										**4.6**		
Reno	4,527	61	76	25.45	30.00	+.02	44.8	+3.8	71	8	58	18	26	32	39	36	25	51	.04	−.8	2	5,780	w.	32	w.	29	16	10	5	3.7	.4	.0
Tonopah	6,090	12	20	.....	.....	.....	43.0	.....	62	20	53	14	26	33	26	33	19	42	.37	.....	2	.....	nw	----	----	----	----	----	----	----	----	----
Winnemucca	4,344	18	56	25.57	30.01	.00	40.8	+.8	72	20	56	14	26	26	42	33	24	56	.35	−.6	5	6,835	ne.	27	sw.	31	14	8	9	4.3	4.4	.2
Modena	5,473	10	46	24.53	29.90	−.06	40.4	+2.2	68	9	55	16	23	26	45	31	20	52	.67	−.4	5	7,537	w.	38	w.	31	12	10	9	4.4	6.3	.0
Salt Lake City [1]	4,357	86	210	25.68	29.97	−.01	40.4	−1.3	68	17	52	21	23	29	36	34	27	61	1.21	+.8	7	7,344	se.	41	w.	29	9	10	12	5.9	10.1	8.0
Grand Junction	4,602	60	68	25.27	29.85	−.09	44.9	+1.3	68	9	57	25	27	32	32	35	21	44	.57	−.2	5	5,390	se.	34	w.	31	12	12	7	4.7	3.9	.0
Northern Plateau							**39.6**	**−1.6**										**59**	**0.72**	**−0.4**										**6.3**		
Baker	3,471	48	53	26.44	30.08	+.03	35.1	−2.5	63	20	45	10	30	25	34	31	23	63	.98	−.1	15	4,841	se.	24	sw.	27	8	11	12	6.1	6.7	.5
Boise	2,739	79	87	27.18	30.07	+.04	40.2	−2.5	68	20	50	19	31	30	35	34	25	58	.73	−.6	11	4,782	se.	24	nw.	9	6	12	13	6.7	4.8	2.0
Pocatello	4,477	60	68	25.42	30.01	.00	35.2	−2.2	57	20	44	16	25	27	26	30	23	63	1.48	+.2	11	7,607	se.	30	sw.	9	7	11	13	6.3	10.0	7.4
Spokane	1,929	101	110	27.92	30.00	−.01	38.7	−1.0	63	20	47	18	31	30	33	34	27	64	.58	−.6	5	6,223	s.	25	sw.	26	3	16	12	6.5	2.1	T
Walla Walla	991	57	65	28.96	30.04	+.02	45.2	−.9	70	2	54	22	30	37	30	39	30	56	.50	−1.1	5	5,524	sw.	32	w.	27	7	10	14	6.4	3.6	T
Yakima	1,076	58	67	28.86	30.03	.....	43.3	−.8	69	20	54	20	30	33	34	36	26	51	.05	−.3	3	5,223	nw.	29	w.	27	7	11	13	6.0	.2	.0
North Pacific Coast Region							**44.2**	**−1.2**										**74**	**3.28**	**−1.0**										**7.6**		
North Head	211	11	56	29.90	30.13	+.12	43.0	−2.2	55	1	47	29	31	39	14	41	38	83	4.59	−1.0	23	10,920	nw.	47	nw.	21	1	5	25	8.3	4.0	.0
Seattle	125	90	321	29.93	30.07	+.08	44.0	−.9	62	2	50	30	31	38	22	40	34	69	2.14	−.9	14	8,038	s.	42	s.	14	3	9	19	7.5	1.1	.0
Tatoosh Island	86	10	54	29.96	30.06	+.10	41.8	−1.1	52	19	45	30	28	38	14	40	36	79	7.67	−.2	22	11,831	w.	45	w.	20	3	9	19	7.7	1.2	.0
Medford	1,329	29	58	28.68	30.11	.....	46.6	.....	79	20	59	23	30	34	48	41	34	68	.42	−1.3	6	.....	nw.	----	----	----	7	7	17	6.5	.5	.0
Portland, Oreg	153	68	106	29.95	30.12	+.10	45.3	−1.6	67	19	52	31	30	38	27	41	36	73	3.10	−.8	14	4,955	nw.	25	nw.	21	3	5	23	8.0	1.6	T
Roseburg	510	45	76	29.59	30.14	+.10	47.0	−.1	72	20	57	29	30	37	37	43	38	72	1.76	−1.5	14	3,499	n.	19	sw.	26	2	7	22	7.7	1.0	.0
Middle Pacific Coast Region							**53.8**	**+1.6**										**63**	**1.37**	**−2.3**										**4.8**		
Eureka	62	73	89	30.07	30.14	+.08	47.8	−.5	66	4	54	35	30	42	23	45	42	82	1.77	−3.5	9	6,378	n.	34	n.	21	9	11	11	5.5	T	.0
Redding	722	20	34	.....	.....	.....	57.5	.....	84	2	68	33	30	46	30	46	31	40	1.34	.....	4	6,872	nw.	31	ne.	21	10	6	15	6.2	.3	.0
Sacramento	69	92	115	29.92	29.99	−.04	56.3	+2.0	76	19	67	34	25	45	32	49	42	62	1.33	−1.2	3	5,704	s.	35	nw.	22	17	10	4	3.5	T	.0
San Francisco	155	208	243	29.84	30.01	−.05	57.4	+3.2	77	1	65	42	25	50	27	50	44	68	1.01	−2.1	4	5,237	w.	34	nw.	24	16	8	7	4.1	.0	.0
South Pacific Coast Region							**58.2**	**+1.8**										**71**	**1.21**	**−0.8**										**4.7**		
Fresno	327	97	103	29.64	30.00	−.01	58.1	+3.1	82	19	70	34	26	47	31	52	46	67	1.36	−.2	3	4,360	nw.	28	w.	31	16	9	6	4.0	.0	.0
Los Angeles	338	159	191	29.61	29.98	−.04	59.0	+1.5	85	1	67	42	25	51	31	51	45	70	1.34	−1.4	2	4,398	sw.	20	nw.	22	14	10	7	4.3	.0	.0
San Diego	87	62	70	29.89	29.98	−.04	57.4	+.7	77	1	63	41	26	52	25	52	49	76	.92	−.8	7	5,451	w.	31	w.	25	9	12	10	5.8	.0	.0
West Indies																																
San Juan, P. R	82	9	54	29.90	29.99	.....	75.6	+.2	89	18	81	65	8	70	17	----	----	----	1.43	−1.7	5	7,929	e.	27	e.	10	15	15	1	3.9	.0	.0
Panama Canal																																
Balboa Heights	118	6	92	.....	[3] 29.82	−.02	81.7	+.5	93	13	90	68	2	73	21	----	----	[3] 74	.36	−.3	1	6,665	nw.	26	n.	5	2	27	2	5.0	.0	.0
Cristobal	36	6	97	.....	[3] 29.84	−.03	81.6	+.1	87	17	86	71	2	78	14	75	73	[3] 77	.87	−.7	13	9,504	n.	24	n.	7	5	20	6	5.5	.0	.0
Alaska																																
Fairbanks	454	11	87	.....	[3] 29.93	.....	4.4	.....	39	31	18	−30	1	−9	50	----	----	70	.49	.....	10	3,724	s.	38	s.	23	8	8	15	----	10.4	20.4
Juneau	80	96	116	[3] 29.81	[3] 29.90	.....	32.3	.....	44	5	36	20	22	29	15	30	22	68	7.74	.....	19	6,539	se.	27	ne.	27	6	4	21	7.2	30.7	2.0
Hawaiian Islands																																
Honolulu	38	86	100	[3] 30.00	[3] 30.04	.....	72.2	+.8	81	30	77	62	20	68	15	65	61	71	1.73	−1.5	17	7,739	e.	35	ne.	12	9	7	15	6.4	.0	.0

[1] Observations taken at airport.
[2] Observations taken hourly.
[3] Pressure not reduced to mean of 24 hours.

TABLE 2.—*Data furnished by the Canadian Meteorological Service, March 1936*

Station	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max.+ mean min.÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*In.*	*In.*	*In.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*In.*	*In.*	*In.*
Cape Race, Newfoundland	99				33.2		38.0	28.5	48	16	3.37		1.0
Sydney, Cape Breton Island	48	29.95	30.00	+0.12	35.9	+9.7	43.3	28.5	62	0	4.21	−0.72	9.2
Halifax, Nova Scotia	88	29.75	29.86	−.08	36.2	+7.2	42.2	30.3	57	10	6.03	+.57	.0
Yarmouth, Nova Scotia	65	29.85	29.92	−.03	39.8	+9.0	46.6	33.1	63	15	4.61	−.39	4.5
Charlottetown, Prince Edward Island	38	29.92	29.96	+.06	35.4	+10.0	41.7	29.1	60	4	4.03	+.82	5.6
Chatham, New Brunswick	28	29.86	29.89	−.02	35.0	+10.0	42.4	23.5	60	−17	2.94	−.53	11.4
Father Point, Quebec	20	29.87	29.89	−.01	30.7	+10.4	38.5	22.9	55	−9	.66	−2.07	1.2
Quebec, Quebec	296	29.58	29.92	−.04	31.6	+10.4	38.0	25.1	55	−8	2.72	−.54	2.7
Doucet, Quebec	1,236				21.9		32.4	11.4	47	−40	5.36		42.3
Ottawa, Ontario	236	29.60	29.88	−.13	29.0	+7.5	36.9	21.1	57	−20	4.81	+2.09	11.6
Kingston, Ontario	285	29.55	29.87	−.14	32.3	+6.7	38.9	25.6	57	−2	6.04	+3.40	9.3
Toronto, Ontario	379	29.46	29.89	−.13	34.5	+7.2	40.4	28.5	61	6	4.07	+1.43	20.8
Cochrane, Ontario	930				20.2		29.4	10.9	46	−26	3.93		19.8
White River, Ontario	1,244	28.45	29.80	−.23	19.1	+6.9	30.5	7.8	46	−40	2.85	+1.47	22.1
London, Ontario	808				33.9		41.2	26.6	60	−16	1.77		10.4
Southampton, Ontario	656	29.14	29.87	−.16	29.6	+4.9	36.7	22.6	55	−10	1.35	−1.30	8.7
Parry Sound, Ontario	688	29.14	29.84	−.18	28.0	+6.9	35.0	21.0	53	−12	2.98	+.75	18.9
Winnipeg, Manitoba	760	29.01	29.87	−.22	18.1	+5.8	27.0	9.2	40	−25	1.89	+.86	18.1
Minnedosa, Manitoba	1,690	27.99	29.87	−.19	18.4	+5.9	27.5	9.2	42	−28	1.39	+.74	13.6
Le Pas, Manitoba	860				16.4		26.6	6.3	48	−18	2.02		20.2
Qu'Appelle, Saskatchewan	2,115	27.53	29.84	−.20	20.7	+5.8	29.0	12.4	45	−12	3.05	+2.28	29.3
Moose Jaw, Saskatchewan	1,759				23.5		31.1	16.0	48	−9	1.29		12.9
Swift Current, Saskatchewan	2,392	27.28	29.89	−.13	23.8	+1.8	30.6	17.1	49	−6	.98	+.17	9.8
Medicine Hat, Alberta	2,365	27.38	29.92	−.08	28.9	+1.4	36.6	21.3	55	−5	.95	+.19	8.4
Calgary, Alberta	3,540	26.18	29.97	+.02	25.4	−.8	33.7	17.0	58	−5	.84	−.18	5.4
Prince Albert, Saskatchewan	1,450	28.30	29.93	−.15	20.6	+8.6	29.7	11.6	48	−3	.40	−.37	3.8
Battleford, Saskatchewan	1,592	28.13	29.93	−.13	20.3	+7.2	30.3	10.4	46	−5	.06	−.40	.6
Edmonton, Alberta	2,150	27.57	29.92	−.04	24.6	+.4	33.5	15.6	52	−10	.29	−.43	2.9
Kamloops, British Columbia	1,262	28.66	29.98	+.06	36.1	.0	44.6	27.6	56	12	.31	−.26	1.3
Victoria, British Columbia	230	29.80	30.06	+.09	42.0	+.1	46.7	37.4	56	27	2.32	−.80	.7
Estevan Point, British Columbia	20				40.4		45.8	35.0	50	25	12.76		.1
Prince Rupert, British Columbia	170				33.9		39.3	28.6	47	19	7.89		4.0
LATE REPORTS FOR FEBRUARY 1936													
Father Point, Quebec	20	29.87	29.90	−0.08	11.5	0.0	18.0	5.0	42	−8	1.37	−0.84	13.5
Doucet, Quebec	1,236				−3.6		10.3	−17.4	41	−48	2.06		19.6
Ottawa, Ontario	236	29.77	30.06	+.04	6.7	−5.0	17.1	−3.6	41	−20	2.06	−.63	19.6
London, Ontario	808				12.9		21.8	4.0	44	−11	2.65		18.3
Parry Sound, Ontario	688	29.28	30.02	+.01	7.8	−6.5	16.4	−.7	41	−23	3.71	+.79	36.8
Port Arthur, Ontario	644	29.32	30.08	+.03	−2.8	−9.2	7.2	−12.8	31	−27	.15	−.75	1.5
Winnipeg, Manitoba	760	29.29	30.20	+.10	−14.0	−12.4	−4.9	−23.1	18	−43	1.40	+.42	14.0
Minnedosa, Manitoba	1,690	28.22	30.20	+.13	−14.8	−12.1	−4.4	−25.2	20	−46	.52	−.09	5.2
Moose Jaw, Saskatchewan	1,759				−15.2		−6.6	−23.9	33	−48	.68		6.8
Medicine Hat, Alberta	2,365	27.57	30.28	+.23	−15.8	−27.0	−6.0	−25.6	45	−49	.83	+.16	8.3
Edmonton, Alberta	2,150	27.80	30.31	+.29	−17.0	−25.3	−7.5	−26.5	53	−51	.58	−.09	5.8
Kamloops, British Columbia	1,262	28.75	30.12	+.16	5.0	−23.3	13.1	−3.2	49	−24	1.58	+.79	15.8
Victoria, British Columbia	230	29.66	29.92	−.08	33.2	−6.3	37.5	28.8	49	9	4.76	+.66	8.1
Estevan Point, British Columbia	20				36.5		42.5	30.4	50	21	9.21		3.6
Prince Rupert, British Columbia	170				23.4		30.4	16.4	45	2	3.79		23.1

SEVERE LOCAL STORMS, MARCH 1936

[Compiled by Mary O. Souder from reports submitted by Weather Bureau officials]

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Big Sioux Valley, S. Dak.	6–15				$6,500	Flood	Flood due to rapidly melting snow; damage to tangible property.
Harrisburg, Pa., and vicinity	7–8	P. m.			110,000	Ice and flood	Temporary gorging accompanying the ice movement on the night of the 7th–8th resulted in very high water stages between the northern limits of the city and Speeceville. Great damage to property occurred along both sides of the river along this stretch. The destruction was almost entirely done by huge cakes of ice which were thrown over the banks and across highways; destruction and damage to buildings, highway retaining walls and highways; water and ice filled the Dauphin subway and Narrows; all traffic northward tied up until evening of the 8th.
Miami, Fla.	9	6:50 p. m.		1	50,000	Squall	Wind had tornadic characteristics; 35 persons injured by flying debris; property damage $50,000, being confined to flimsily-constructed houses, carnival equipment and plate glass windows; all debris blown in one general direction.
Wilmington, N. C.	9–10					Rain	Considerable damage to truck by flooding.
Providence, R. I.	9–22				200,000	Rain and flood	In the Blackstone Valley the city of Woonsocket had heavy losses from the flood; about 50 families had to evacuate their homes; several factories closed.
Oklahoma Panhandle	10					Dust	Choking dust clouds swept over this region. At Woodward on the edge of the Oklahoma "dust bowl", as at some other points, visibility was reduced to 2 blocks, slowing highway traffic, and at Beaver to half a mile
New York, south-central and eastern portions.	12					Flood	Much flooding of lowlands and cellars; some local damage to highway bridges and railroads.

Severe local storms, March 1936—Continued

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Northfield, Vt.	12					Rain and flood	Rain, which fell all day of the 12th, and warm temperature rapidly melted the large amount of snow on the ground. The rivers, mostly ice-covered, jammed, overflowing their banks in many places. At Northfield, streets near the river were covered in places with water to a depth of 3 feet or more; many cellars flooded.
Trenton, N. J.	12					do	Rain caused breaking up of ice jams in upper part of river; large ice floes did great damage. Roads on both sides of river blocked; business interests damaged and inconvenienced.
Harrisburg, Pa., and vicinity	12–13				40,000	Flood	Damage to property.
Buffalo, N. Y., and vicinity	13			3		Blizzard	Maximum wind velocity of 61 miles an hour recorded; walking and driving hazardous; 2 deaths caused by poor visibility when an automobile was hit by a New York Central train; in Lancaster, one death occurred when a man slipped and was struck by a train; Fuhrmann Drive closed during height of storm; numerous cars stalled on the boulevards.
Colorado, southern portion	15					Dust	Worst dust storm of the year; daylight turned into darkness.
Brownsville, Tenn.	15					Electrical	House and barn destroyed; 4 cattle killed by lightning.
Augusta, Ga.	16	11–12 p. m.		0		Tornado	Within a 4-mile radius southward from the business section of Augusta; 2 houses and a garage completely demolished, 5 houses damaged; 10 persons injured, 2 seriously.
Cleveland, Ohio	16–18				2,000	Snow and wind	5.9 inches of snow fell within 24 hours on the 16th–17th, greatest of record for March, resulting in serious traffic difficulties. Severe northerly gale during the night of 17th–18th, causing snow to drift; 30-foot chimney blown down; building damaged; several large windows broken.
Pittsylvania County, Va., north-central portion.	14	5:30 a. m.		0	45,000	Tornado	Damage mostly to trees and buildings; width of path from a few hundred yards to half a mile.
Knoxville, Tenn.	17	a. m.				Snow	Heavy snowstorm beginning in the early morning continued until late afternoon; depth of snow in the downtown area 2.6 inches; in suburban sections much deeper and averaged up to 2 feet in the mountain districts east of Knoxville.
Greenville and Pickens Counties, S. C.	17	9 a. m.; 9 p. m.	[1]6		400,000	Wind	Property damage $25,000 and to forests $375,000; old residents declared this to be the worst storm of its kind in their remembrance.
Savannah, Ga.	17					do	Small hangar at airport destroyed; some damage to airplanes; light damage to signs, trees, wires, and window panes; 4 persons slightly injured when struck by flying glass.
New York, western portion	17				100,000	Heavy snow	Much damage to roofs and small buildings; property loss in Buffalo and vicinity $100,000; considerable loss in smaller cities and towns.
Rochester, N. Y., and vicinity	17–18				826,825	Glaze	Much damage to trees; many old orchards ruined; severe loss to telephone and electric lines; damage to the Rochester Telephone Corporation $400,000 and to the Electric Corporation, $75,000.
Asheville, N. C.	17–18					Snow and high winds.	Ground covered by 10 a. m., of the 17th; by nightfall traffic and commerce was completely suspended; schools in outlying districts unable to return 75 pupils to their homes during the storm. Drifts of 5 feet general throughout the city. Schools closed on the 18th.
Erie, Pa.	17–18					Snow and wind	16.1 inches of snow recorded in 24 hours; storm especially severe on account of wind making large drifts; streets and walks slippery; many automobiles stalled.
Trenton, N. J.	17–19				125,000	Rain and flood	Moderately heavy rains fell on already saturated ground and drained rapidly into the river; business interests and residences on both sides of the river inundated; a home on the island in Morrisville carried away. Damage estimated for Trenton only.
Buffalo, N. Y., and vicinity	17–21			5	655,000	Snow	24-hour snowfall of 19 inches recorded. Street-car service ceased; conditions bad for automobile, bus, and other traffic; many highways closed; several persons injured; more than 100 families had to be removed from their homes by boat and truck; property loss for Buffalo and vicinity $100,000; the Peace Bridge Arena, with estimated damage of $25,000, and 6 or more small buildings collapsed during or immediately after the storm of the 17th. March 21; heavy snow fell from 3 a. m., until 7 p. m., with total of 9.7 inches; several roofs on small garages collapsed; Buffalo airport officially closed 17th to 26th; public schools closed 19th and 20th; the One hundred and sixth Artillery called out with their 55 tractors to help in the snow cleanup; considerable loss in Jamestown, Niagara Falls, Lockport, and other small towns in this vicinity.
New York, south-central and eastern New York.	18			2	4,492,550	Flood	Heavy damage of lowland dwellings and factories; hundreds of cellars flooded; much damage to highways and bridges.
Scranton, Pa.	18					Rain and flood	Rain fell steadily all night of the 18th; the Lackawanna River at Scranton rose over its banks. Water rose above the first floors of houses in the "flats" sections in the northern part of city. People marooned and travel possible only by boat; many rescued by police and firemen.
Vermont	18					do	Rivers overflowed their banks and considerable damage resulted throughout the State. Cellars were flooded, streets washed or undermined, and washouts on railroads tied up traffic from 2 days to more than a week. Most severe damage was on the Connecticut River in the eastern part of the State. The 2 flood-control dams, completed last fall at East Barre and Wrightsville, Vt., probably saved the Winooski Valley from one of the worst floods in its history; streets flooded in Northfield.
Harrisburg, Pa.	18–19				1,883,200	Flood	1,107 acres inundated; 2,858 buildings flooded, including 262 business houses; huge loss to public utilities not included in amount estimated above.
Virginia, river districts throughout the State.	18–20			4	1,603,500	do	Damage to highways and bridges, $500,000, included in amount above; flood stages in some portions of the State were the highest for nearly half a century.
Scranton, Wilkes-Barre, and Kingston, Pa., and vicinity.	20	2 a. m.			25,225,000	do	The Susquehanna at Wilkes-Barre reported to have reached flood stage at 2 a. m. Most of Kingston, on the west side of the Susquehanna opposite Wilkes-Barre under 8 or 10 feet of water; parts of residential and business sections of Wilkes-Barre flooded; sidewalks and pavements washed out and streets and lawns covered with river mud and silt a foot thick. In Wilkes-Barre, and vicinity, 14,000 persons homeless and $25,000,000 loss; damage in Scranton, $25,000; in Lackawanna County outside of Scranton, $200,000.
Charleston, S. C.	20	1:10 p. m.	33	0	4,000	Wind	Damage mostly to windows and roofs; some windows blown out; path a mile long.
Augusta, Ga., 5 miles west	20			0		Tornado	Small tornado passed near the western edge of Augusta; a garage taken off its foundation, 4 houses damaged, and trees uprooted.
Syracuse, N. Y.	20				75,000	Flood	State highway along Onondaga Lake between Liverpool and Syracuse flooded to a depth of several feet; highway closed to traffic last 11 days of month; grounds along Onondaga Parkway adjacent to the lake and small buildings thereon damaged by high water and ice.
Columbia, S. C.	20				500	Wind	Damage to Columbia Sesquicentennial decorations.
Spencer, S. Dak.	20			1		do	A sudden gust of wind blew a child against a school bus, causing her death.
Chattanooga, Tenn.	20					do	A dwelling demolished by wind; other damage consisted mainly of broken windows, branches of trees, and wires.

[1] Miles instead of yards.

Severe local storms, March 1936—Continued

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Stanislaus County, Calif.	20	7 p. m.	[1] 20		20,000	Wind	Large trees blown down; buildings and crops damaged; storm extended from Modesto to Newman.
Denver, Colo.	22–23					Snow	In the mountains west of Denver the snow piled up to a depth of 14 inches; 7.5 inches up to Monday noon in Denver; air mail service interrupted and highway travel slow; west of Mount Harris the wet snow caused a rock slide, stopping travel in and out of Craig. Several days were required to build a detour. In southwestern Colorado, the snow closed the million-dollar highway between Silverton and Ouray; the road from Silverton to Durango also closed and highway crews had to rescue several parties of marooned motorists.
Wisconsin, western portion of State.	22–23			3	125,000	Heavy rain and flood.	Much land inundated; loss at the State fish hatchery at Osceola, $125,000, because of flood; 3 high-school students drowned when their automobile slipped from a flooded highway into a deep ditch.
Webster - Laclede Counties, Mo., and vicinity.	23	2:45 – 3:30 p. m.		4	150,000	Tornado, electrical and hail.	This is the most disastrous tornado to visit southwestern Missouri since the famous Marshfield tornado, 50 years ago this spring. 25 persons were injured. Thunderstorm in southern Lawrence County between 1:30 and 2 p. m. Moderate hail fell in the vicinity of Monett and Aurora. At Marionville heavy hail fell with severe gusts of wind estimated by unofficial observers to be about 60 miles an hour; several apple orchards in this vicinity ruined. The storm moved in a clear-cut area northeastward through the small town of Republic in southwestern Green County where heavy hail fell without particular damage. At Turners Station, about 10 miles east of Springfield, a large amount of huge hailstones fell, completely ruining an automobile. One mile east of Marshfield, at 2:45 p. m., a 78-car, west-bound freight train of the San Francisco Railroad pulled up to a water tower. It became quite dark to the southwest, as a swirl seemed to form and advance. The 44th car, a 20-ton empty steel "hopper" type coal car, was the only one taken from the track by the tornado. The train was standing in a nearly due east-west line. The car was lifted straight up and moved to the north of the track, being uncoupled at both ends and the coupling pins and connections not broken. The tornado struck Rader at about 2:30 p. m. The teacher of the Kilburn school probably saved the lives of her pupils by having them leave the building which was later completely demolished, and lie down on the ground.
Sioux Rapids, Iowa, and vicinity.	23	5:10 p. m.			15,000	Hail and rain	Windows on the west side of nearly every house in town broken by hailstones; the stones crashed through cars; electric signs in business districts shattered; nearly every window in one greenhouse broken; roofs badly damaged and several plate glass windows in store fronts smashed.
Prescott, Ark.	23	9 p. m.			600	Wind	Damage to 2 buildings.
Sage, Ark.	23	11 p. m.	100	0	1,500	Tornado	Large barn destroyed and several small buildings damaged.
Mt. Carroll, Ill.	23				1,200	Wind	Trees, poles, and small buildings blown down.
Dane and Green Counties, Wis., eastern sections.	23				1,700	do	In Dane County, 3 tobacco sheds wrecked; house and barn damaged; loss $700; in Green County, small buildings, silos and windmills damaged to the extent of $1,000.
Oklahoma City, Okla.	23–26					Dust	Dense duststorms occurred on the 23d and 26th; visibility reduced to from 880 to 600 yards for several hours.
Tyler, Tex.	24	1:35 a. m.	[1] 3–6		275,000	Hail and wind	Heavy hail caused $250,000 damage; straight-line winds caused $25,000.
Longview to Texarkana, Tex.	24	2:30 a. m.	[1] 10	0	1,200,000	Tornado	Crop loss of $200,000 included in amount stated.
Bodcaw, Ark., and vicinity	24	3 a. m.	50	0	500	do	Property damaged.
Kilgore, Tex.	24	do			10,000	Hail and wind	$5,000 crop loss due to hail.
Van Duzer, Ark., and vicinity	24	4 a. m.			4,000	Wind	Damage to buildings.
Pastoria to Ulm, Ark.	24	4:30 a. m.	440–1,760	0	30,000	Tornado	4 persons injured; damage to orchards, buildings, rice farms, and equipment; path 35 miles long.
Almyra, Ark., and vicinity	24	5 a. m.	[1] 1	0	5,000	do	Barns and sheds blown down; several houses unroofed; derricks and pumping sheds severely damaged.
Knoxville, Tenn.	24	7:45 a. m.				Thunderstorm	An electric main struck by lightning causing the downtown section to be without lights and power for nearly an hour.
Chattanooga, Tenn.	24	10 a. m.				Wind, rain, electrical.	A number of small buildings leveled; roofs from large buildings ripped off; the Tennessee Electric Power Company reported considerable trouble over its operating area; a power line struck by lightning.
Chicago, Ill.	24					Dust	Duststorms moved in on Chicago from the west, with heavy clouds reducing visibility in many sections. United Air Line pilots report the densest point of the storm over Watertown, Ill., where dust blanketed out the ground completely. The dust wall rose nearly 2 miles above the surface. Planes were flying 9,000 feet to keep above it.
Terre Haute, Ind.	24					do	Dust accompanied southerly winds most of the day and sifted down on the city. During the early morning when a shower occurred, it literally rained mud. Dust sifted through closed windows into houses.
Pleasant Hill, Miss.	24					Thundersquall	3 houses demolished.
Memphis, Tenn.	24			1	50,000	Thundersquall and hail.	4 persons injured; amount given is estimated property damage from wind and lightning.
Pulaski, Tenn.	24				500	Thunderstorm	Damage to buildings.
Winchester, Tenn.	24				25,000	Wind	Property damaged.
Pittston and Duryea, Pa.	24				600,000	Flood	One of the most serious results was the flooding of the anthracite mines by the Lackawanna River. 7,000 men out of work for an indefinite period; $600,000 appropriated by U. S. Government for pumping out the water.
Buffalo, N. Y., and vicinity	25–28			1	300,000	do	6 or more bridges damaged or washed out; worst flood conditions in South Buffalo, Amherst, and Ellicott Creek sections; 20 square miles in Amherst section inundated on the 27th by flood waters from Tonawanda, Ellicott, and other creeks; many families on farms marooned; in Jamestown area there were similar conditions, with estimated property damage of over $50,000. 1 death by drowning.
South Dakota, southern portion.	26	A. m.				Blizzard	Air filled with particles of hard driven snow; visability reduced to less than a block in Sioux Falls; at Yankton, 4.5 inches of snow fell, and at Sioux Falls 3.5 inches. Dust was reported at the same time snow was falling at these 2 stations.
Lake Village, Ark.	26	5 p. m.			1,000	Wind	Damage to buildings.
Monument, Colo.	26				600	do	C. C. C. barracks blown down.
Walla Walla, Wash.	26–27					2 duststorms	2 strong duststorms occurred on the 26th and 27th. They were unusually severe and of longer duration than is common at this station, and resulted in heavy dust deposits. On the 27th, artificial light was necessary in the early afternoon; visibility 600 feet at height of storm. Rain that fell through the dust caused a coating of mud to be deposited.
Tucumcari and Clovis, N. Mex., and Oklahoma Panhandle.	30					Duststorms	Traffic virtually paralyzed by silt-laden clouds carried by a 40-mile wind. The mercury fell from 68° to 24° at Guymon, Okla. This storm extended eastward as far as Enid, Okla.

[1] Miles instead of yards.

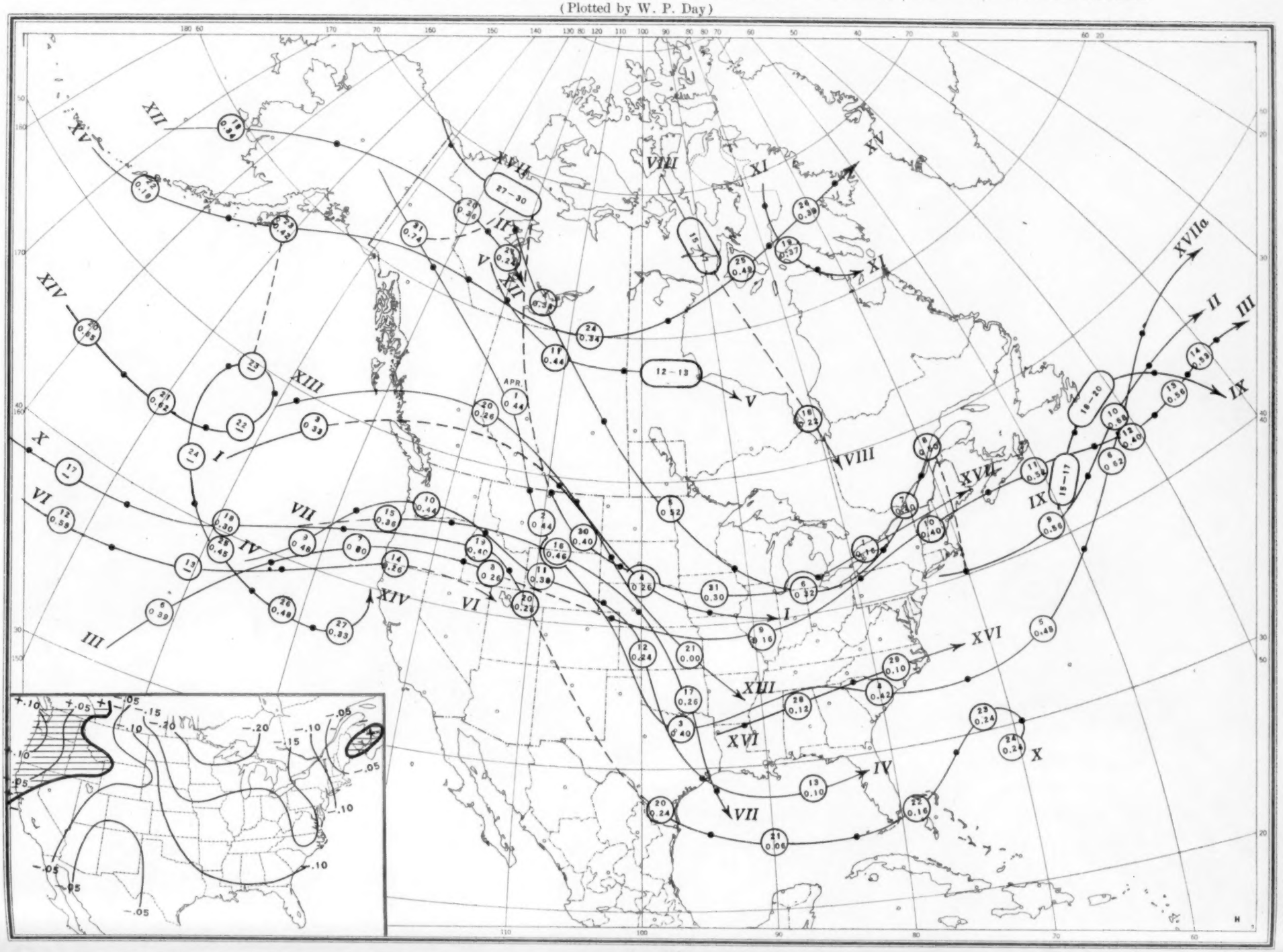
Chart I. Departure (°F.) of the Mean Temperature from the Normal, March 1936

Chart I. Departure (°F.) of the Mean Temperature from the Normal, March 1936

Shaded portions show excess (+)
Unshaded portions show deficiency (−)
Lines show amount of excess or deficiency
Statute Miles
Kilometers

Chart II. Tracks of Centers of Anticyclones, March 1936. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by W. P. Day)



Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, March 1936. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by W. P. Day)

Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

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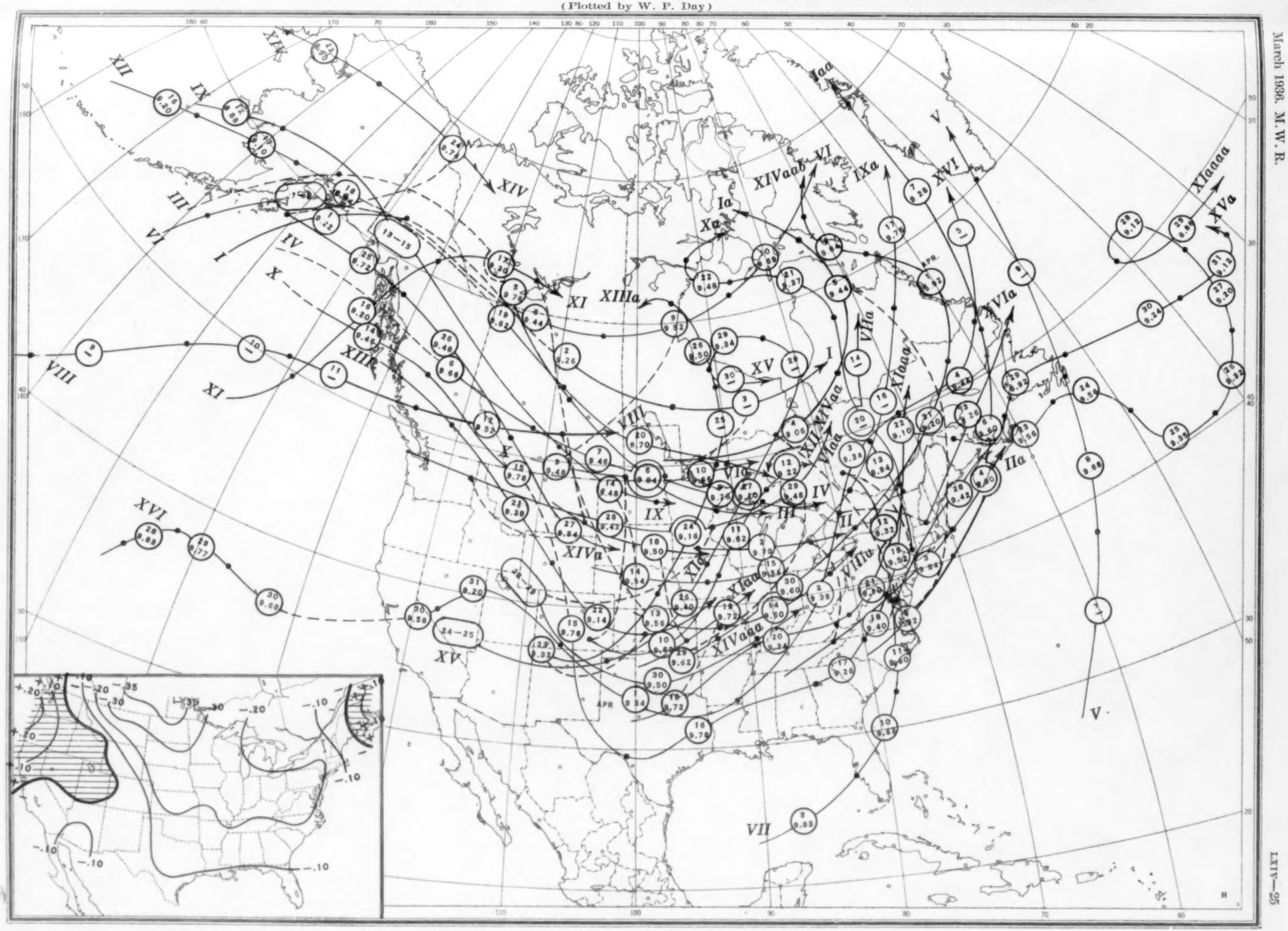
(Plotted by W. P. Day)



Circle indicates position of cyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 8 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky Between Sunrise and Sunset, March 1936

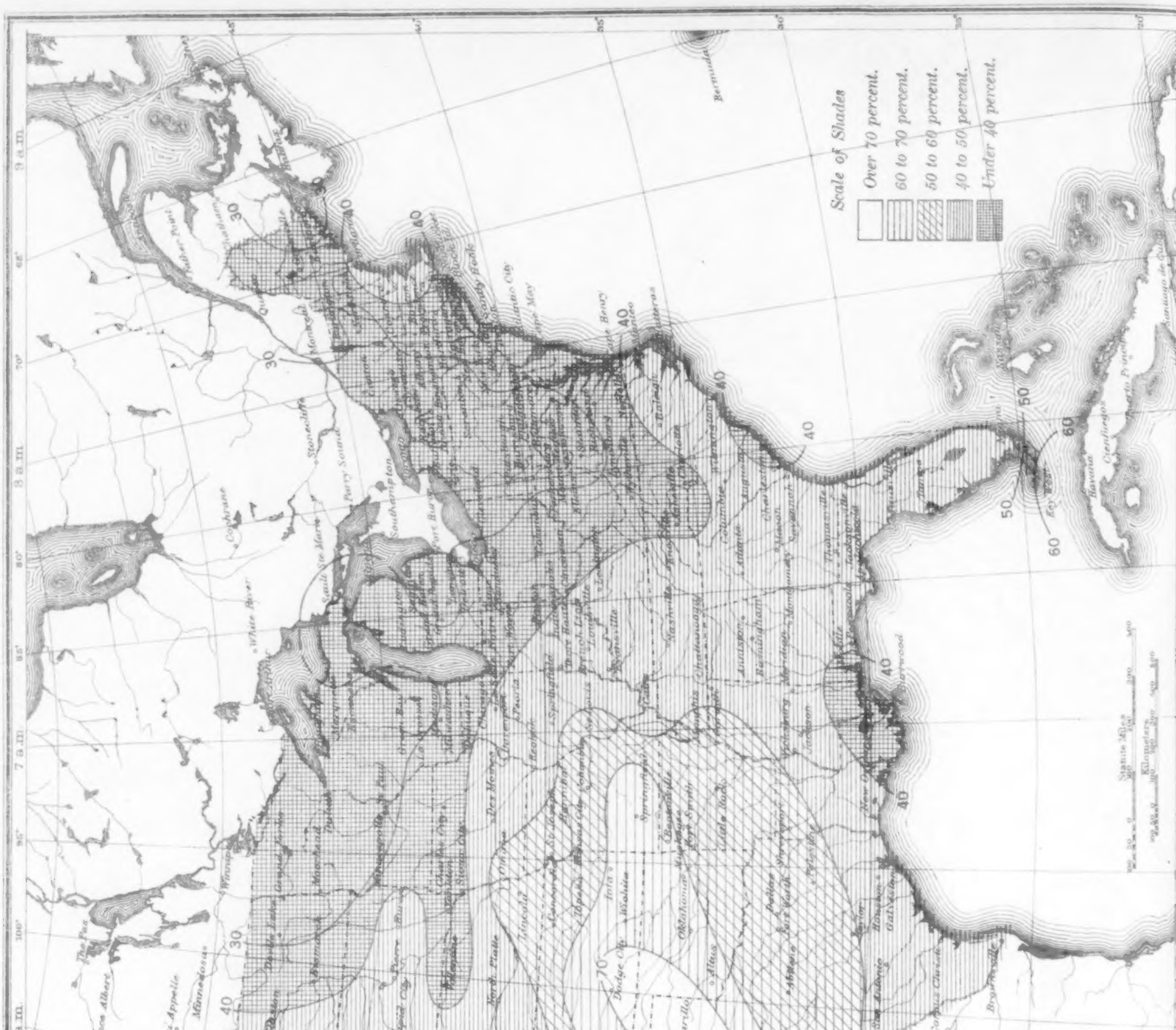


Chart V. Total Precipitation, Inches, March 1936. (Inset) Departure of Precipitation from Normal

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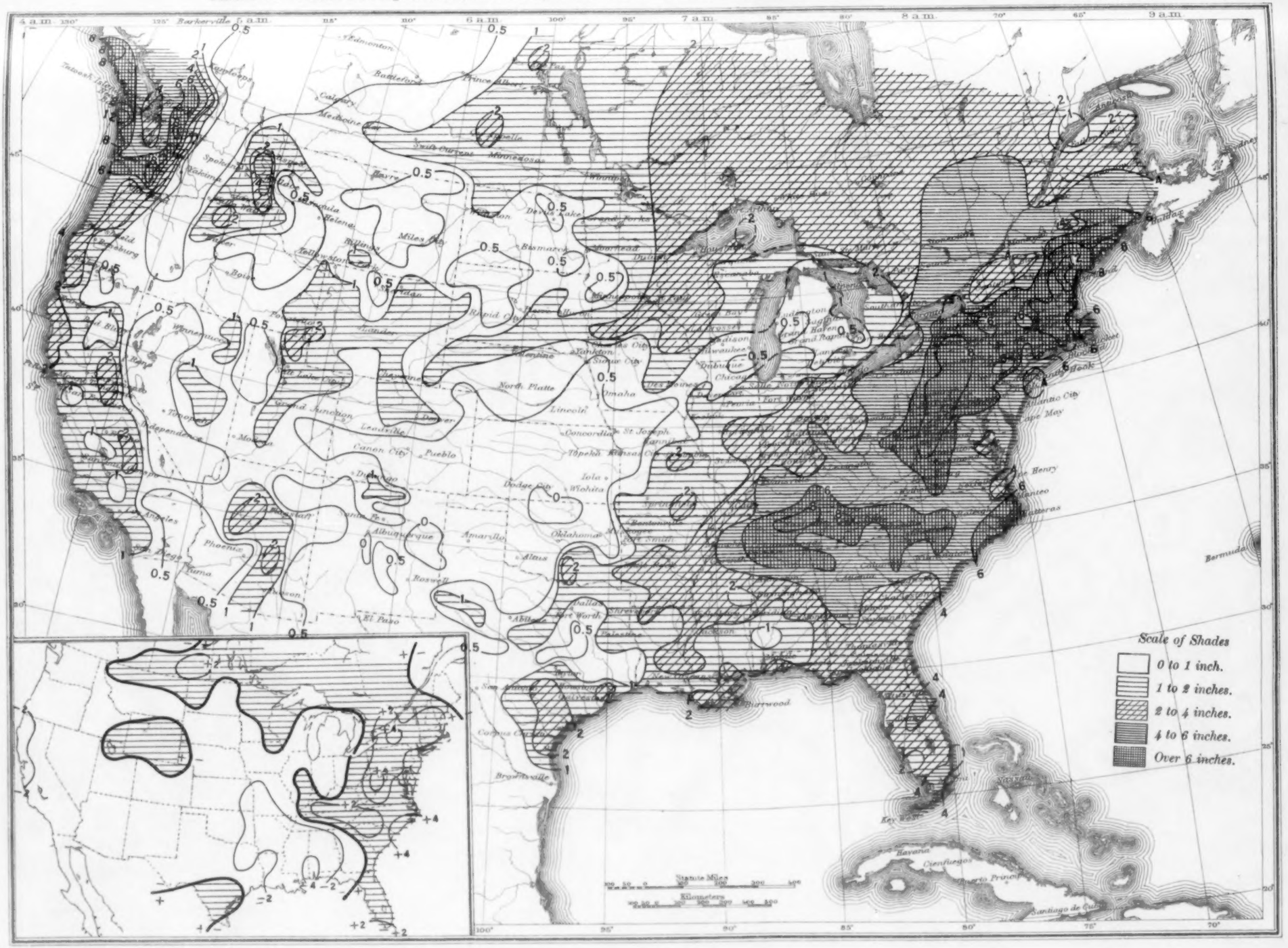

Chart VI. Isobars at Sea Level and Isotherms at Surface; Prevailing Winds, March 1936

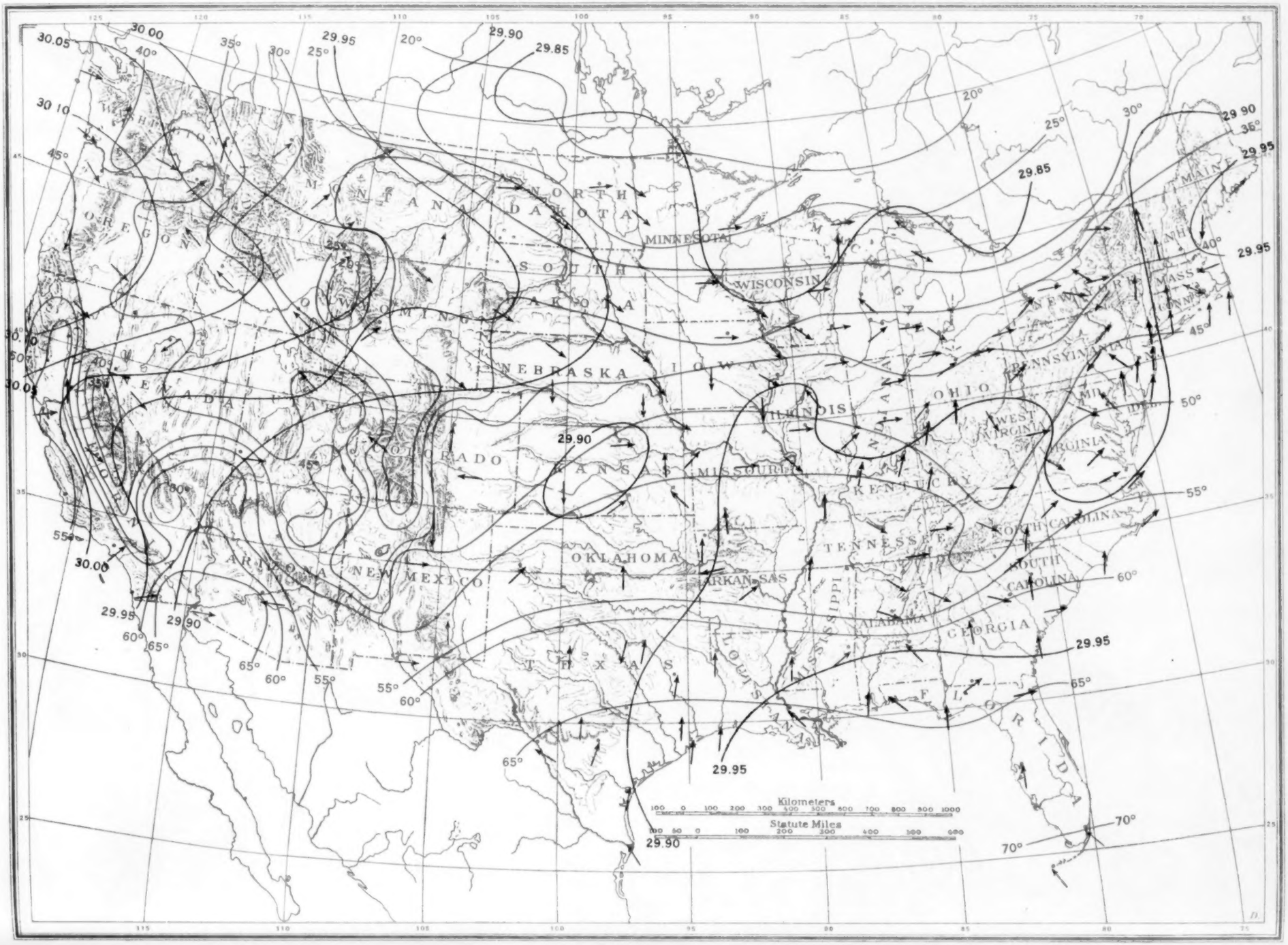

Chart VII. Wind Roses for Selected Stations, March 1936

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(Plotted by W. W. Reed)

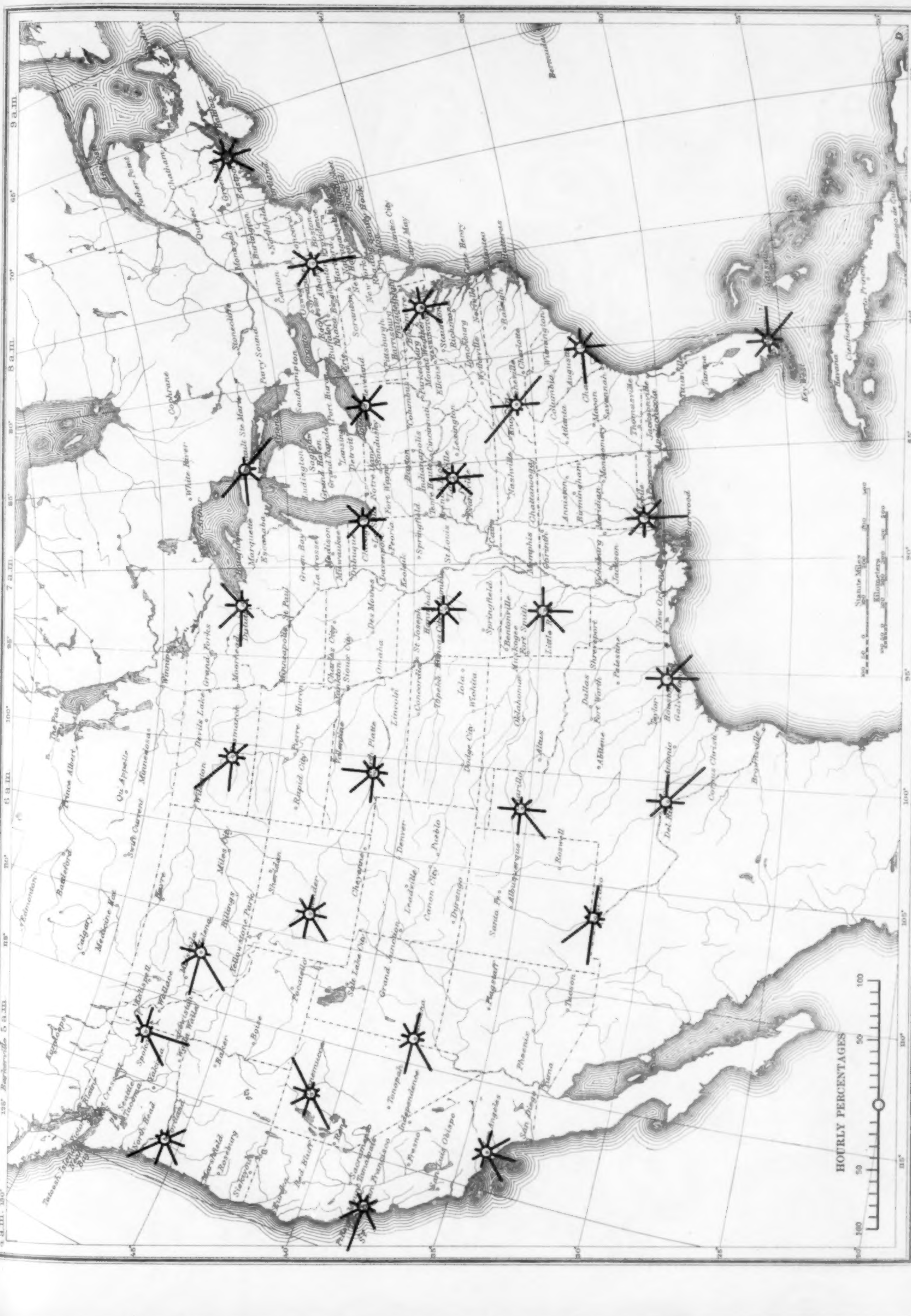

Chart VIII. Total Snowfall, Inches, March 1936. (Inset) Depth of Snow on Ground at 8 p. m., Monday, March 23, 1936

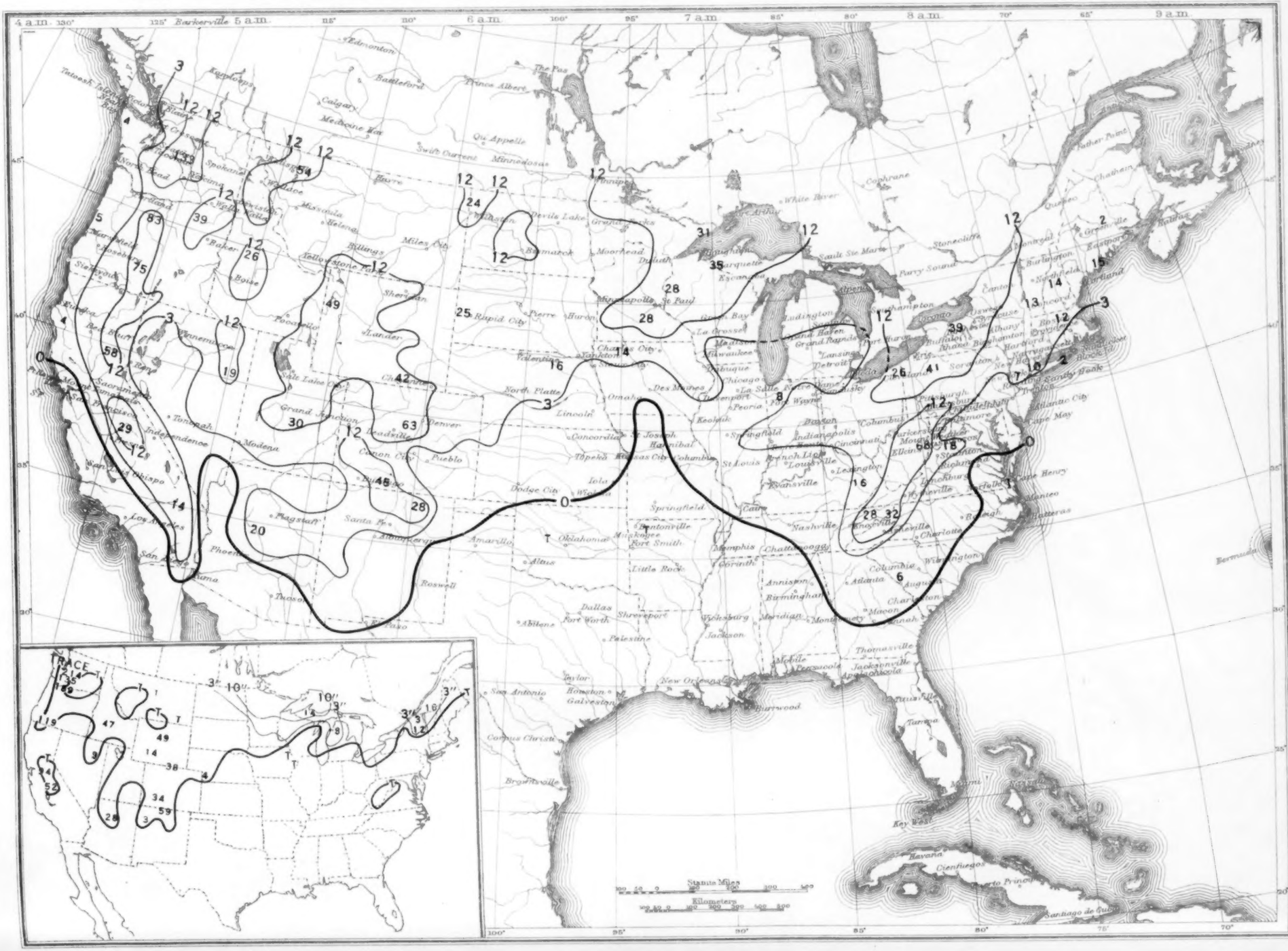

Chart IX. Weather Map of North Atlantic Ocean, March 10, 1936

(Plotted from the Weather Bureau, Northern Hemisphere Chart.)

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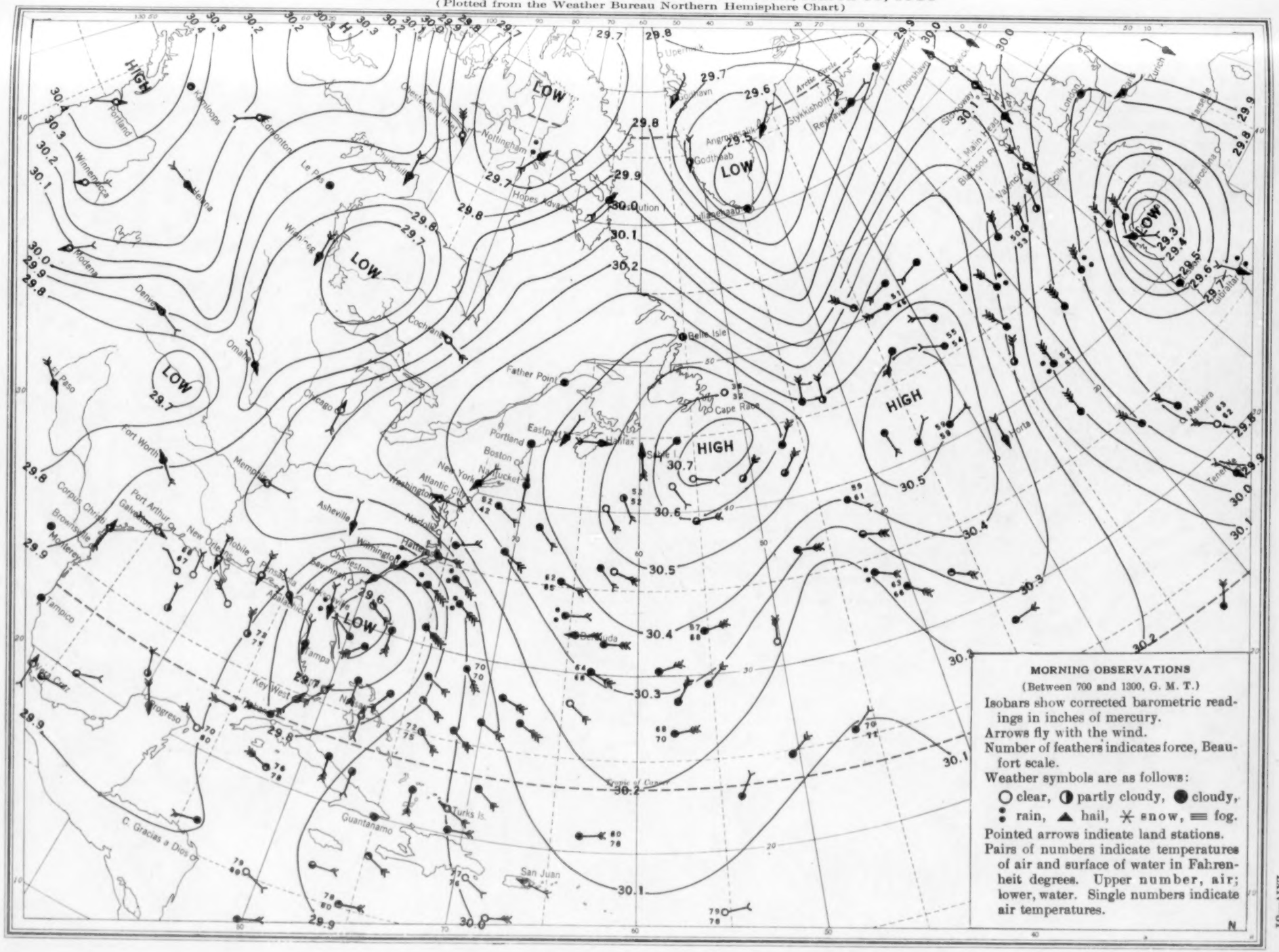
(Plotted from the Weather Bureau Northern Hemisphere Chart)



MORNING OBSERVATIONS

(Between 700 and 1300, G. M. T.)

Isobars show corrected barometric readings in inches of mercury.

Arrows fly with the wind.

Number of feathers indicates force, Beaufort scale.

Weather symbols are as follows:

○ clear, ◑ partly cloudy, ● cloudy,
⁝ rain, ▲ hail, ✳ snow, 〓 fog.

Pointed arrows indicate land stations.

Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water. Single numbers indicate air temperatures.

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Chart X. Weather Map of North Atlantic Ocean, March 11, 1936

(Plotted from the Weather Bureau Northern Hemisphere Chart)

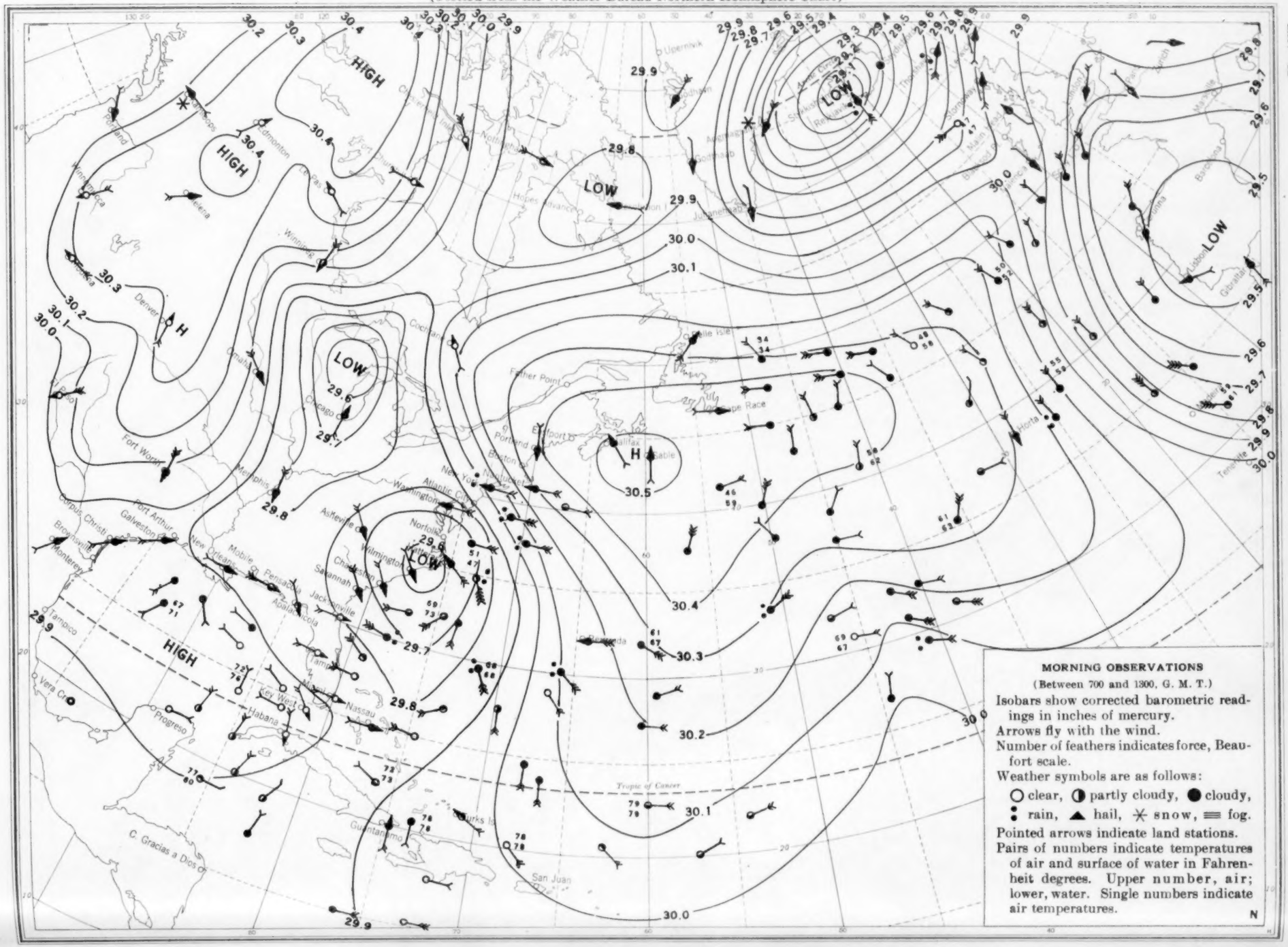
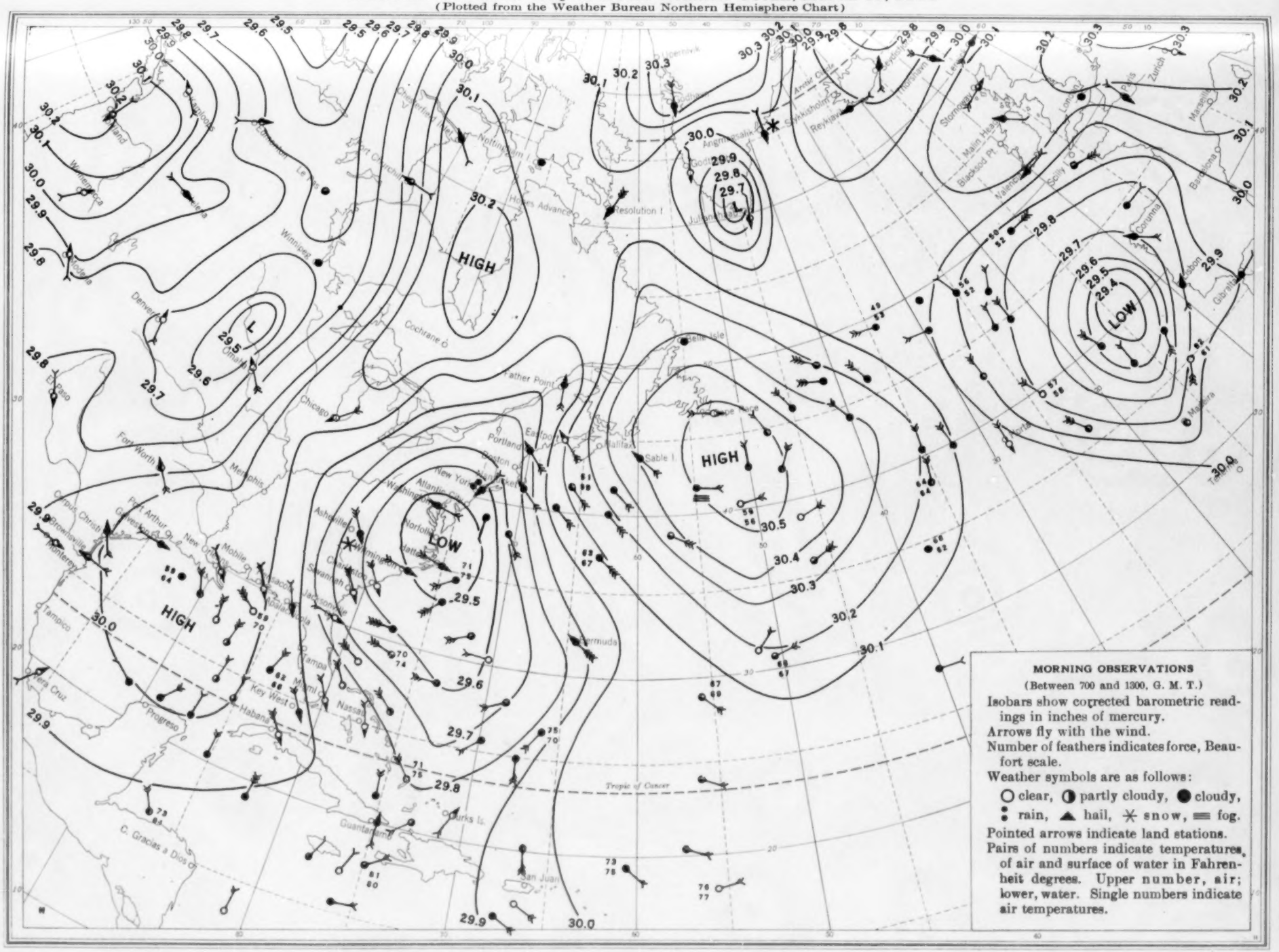


Chart XI. Weather Map of North Atlantic Ocean, March 18, 1936

Chart XI. Weather Map of North Atlantic Ocean, March 18, 1936

(Plotted from the Weather Bureau Northern Hemisphere Chart)


HIGH
LOW
HIGH
LOW
HIGH
L
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Bermuda
Tropic of Cancer
MORNING OBSERVATIONS
(Between 700 and 1300, G. M. T.)
Isobars show corrected barometric readings in inches of mercury.
Arrows fly with the wind.
Number of feathers indicates force, Beaufort scale.
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clear, partly cloudy, cloudy,
rain, hail, snow, fog.
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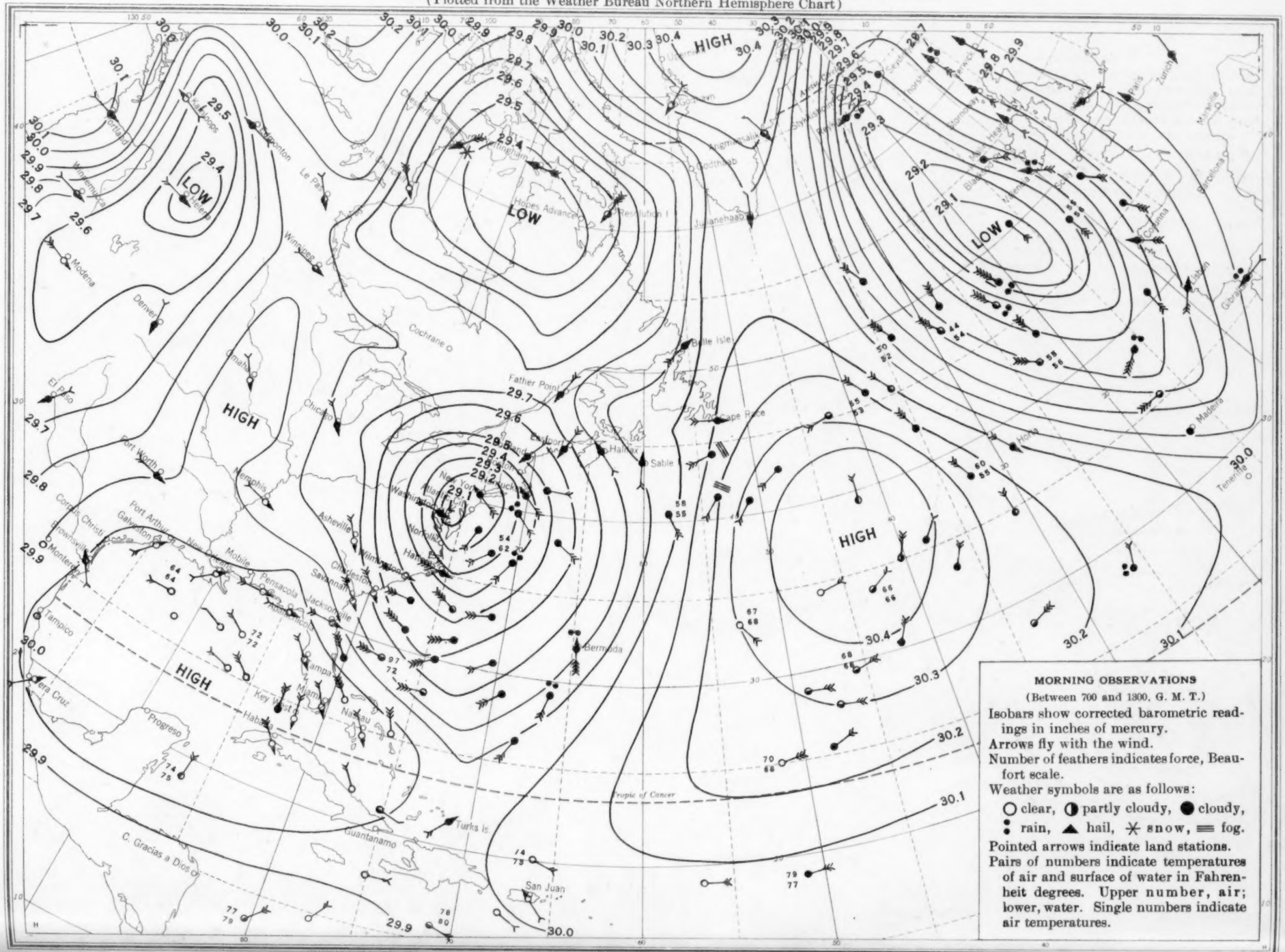
Chart XII. Weather Map of North Atlantic Ocean, March 21, 1936

(Plotted from the Weather Bureau Northern Hemisphere Chart)



MORNING OBSERVATIONS

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